DIAMOND Series

In Geology

Prepared by

Dr. Mina H. Messiha

Mina Hanna

Technical team: 01007765878

Scientific Team: 01284989529

Chapter one

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D.M.RAZK موقع الدكتور محمد رزق معلم الكيمياء التعليمي

Chapter one

Earth's Components.

- **Crust** — "Simaal"
- **Mantle** — "MaFeSi"
- **Core** — "FeNi"

A

Crust.

"8-60 Km"

"Simaal"

Continental Crust.	Oceanic Crust.
Thickness = 60 Km.	Thickness = 8-12 Km.
Mountain	ocean.
"Sial"	"Sima"
70% silicon aluminium.	45% Silicon magnessium.
x Lighter in Colour	x Darker in Colour
x Granite.	x Basalt.
x density = 2.8gm/cm³	x density > 2.8gm/cm³
Continental كبيرة وخفيفة	Oceanic صغيرة وثقيلة
large thickness - low density	small thickness - high density

فى بالان

Balance

Both have lowest Temperature & lowest pressure.

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B

Mantle.

"2900 Km"

"MaFeSi"

upper Mantle		lower mantle.
lithosphere	Asthenosphere.	Thickness = 2550 Km.
Solid state where it is upper part of upper Mantle with Crust.	ductile acts as Fluid (semi-Solid) Causes the Continental drift. (Tectonic force)	Contain: Ma Fe Si magnessium Iron Silicon. as Compound.

60 Km. Continental Crust

8-12 Km. oceanic Crust.

not more than 100 Km's

350 Km upper Mantle.

- lithosphere (Solid state)
- Asthenosphere (ductile) → lower Pressure.

(due to high pressure)

2550 Km lower Mantle. ∴ Solid state. ⇒ (Ma Fe Si) = Compound.

inc density.
inc Pressure
inc. Temperature.

movement of Tectonic plate.

Compression or Tension.

Crust.

Tectonic plate

ductile act as Fluid move by Convection Current

appear Earthquake & volacnic

high density. Hot. low density.

lithosphere. Cold low Temp.

High Temp.

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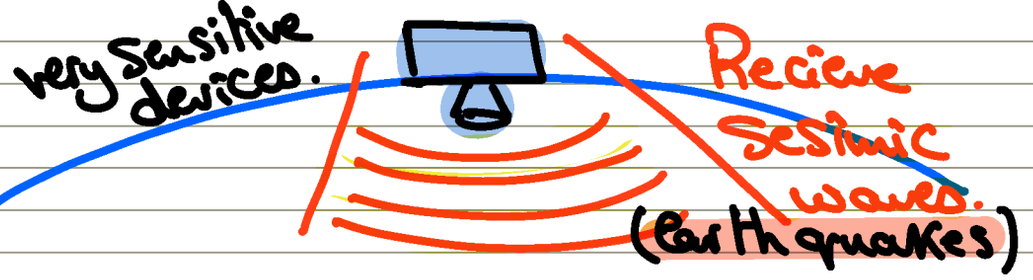
C

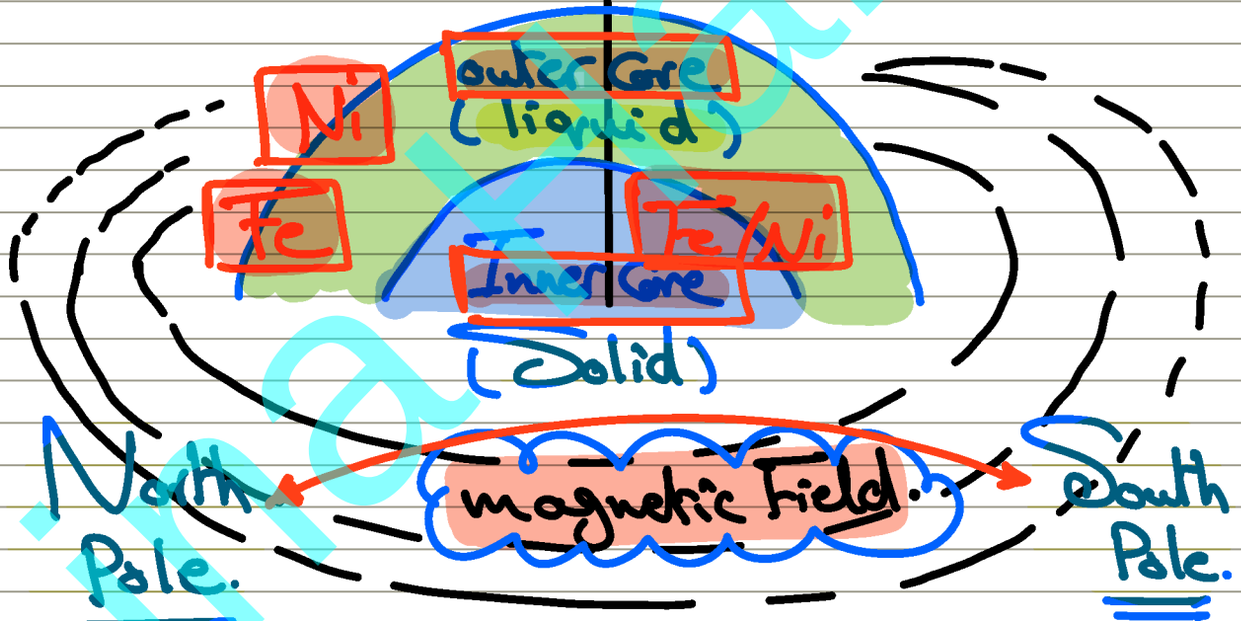
Core.

3486 Km

"FeNi"

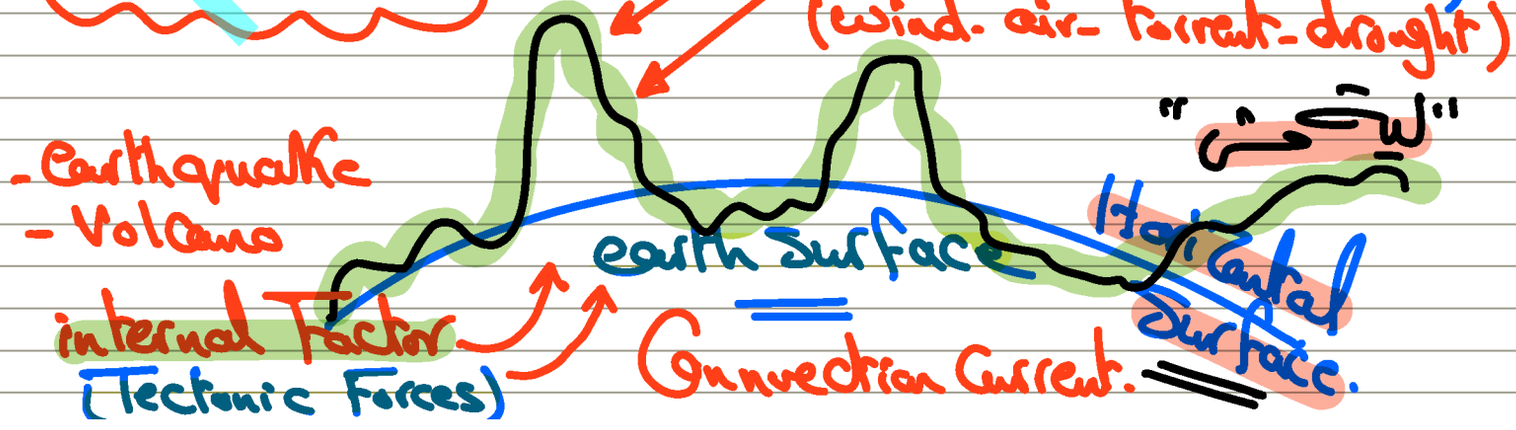


outer Core	inner Core
x Thickness = 2100 Km.	x Radius = 1386 Km.
x low density = 10 gm/cm³	x high density = 14 gm/cm³
x Temp = 5000c°	x Temp = more 5000c°
x pressure = 3 million atm.	x pressure = more 3 million atm.



Introduction :-

external Factor.
(Environmental Condition)
(wind. air- torrent- drought)



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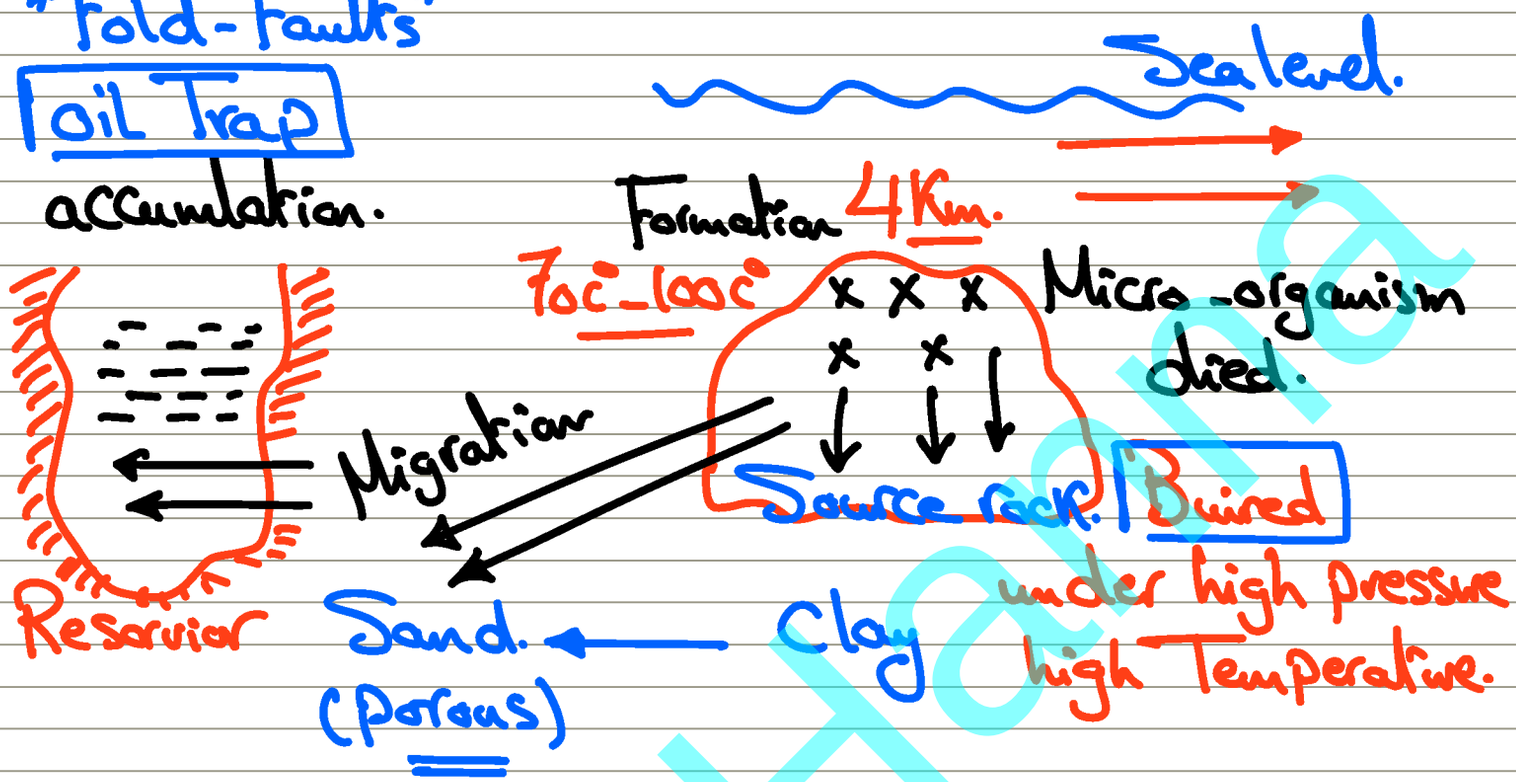
Steps of Formation - migration - accumulation of petroleum oil :

"Fold - Faults"

Oil Trap

accumulation.



Geological Structure

1ry Geological Structure.

Changes during Formation of **sedimentary rocks** due to external Factors. (environmental Conditions).

ex: wind - water - Torrent Temperature.

2ry Geological Structure.

Changes happen after Formation of **any rock** espically sedimentary due to internal Factor. (Tectonic Forces).

ex: Earthquake - volcano.

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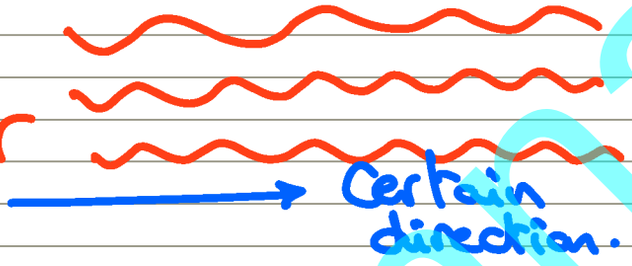
1ry Geological Structure :

Happens during Formation of Rock.
espically **Sedimentary Rocks** (deposition)
due to environmental condition.

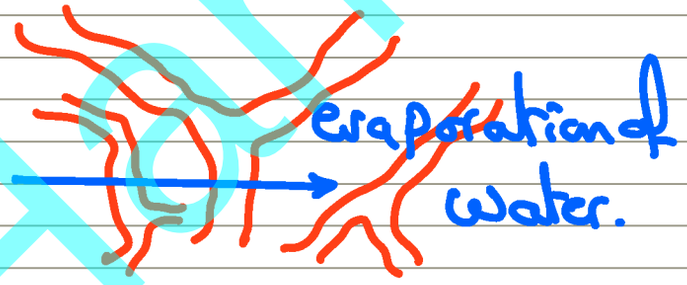
1 Ripple Mark :

air - wind - water Movement.



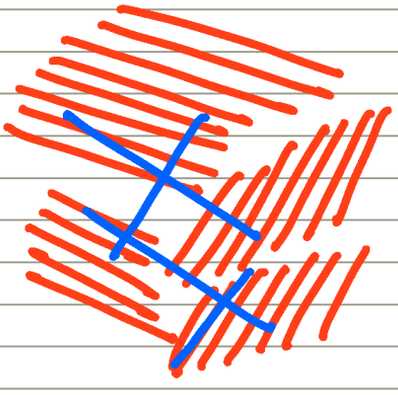
2 Mud - Cracks :

high Temp (drought) in Clay Soil.



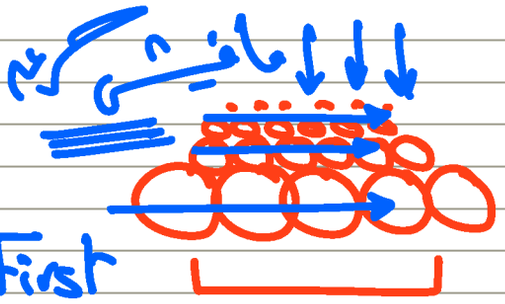
3 Cross - bedding :

water / air Carry Sediments.
↳ Change direction & velocity.



4 Garded - bedding :

Stop water / air velocity
all sediments ppt.
↳ large Sediment Fall First
Then Smaller - lighter ove.



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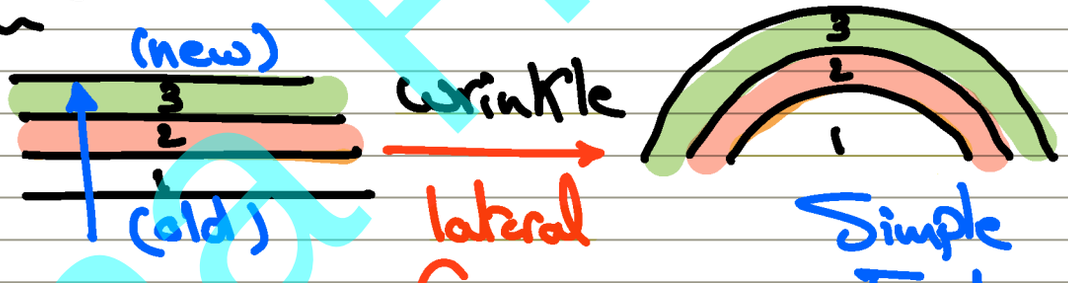
2ry Geological Structure.

Happens after Formation of any rocks appears more clearly in Sedimentary rocks.
due to internal Forces (Tectonic Forces).

- Compression. ضغط
- Tension. شد
- Shearing. عكس بعض

Deformation in Rocks as.
(Fold - Fault - Joints)

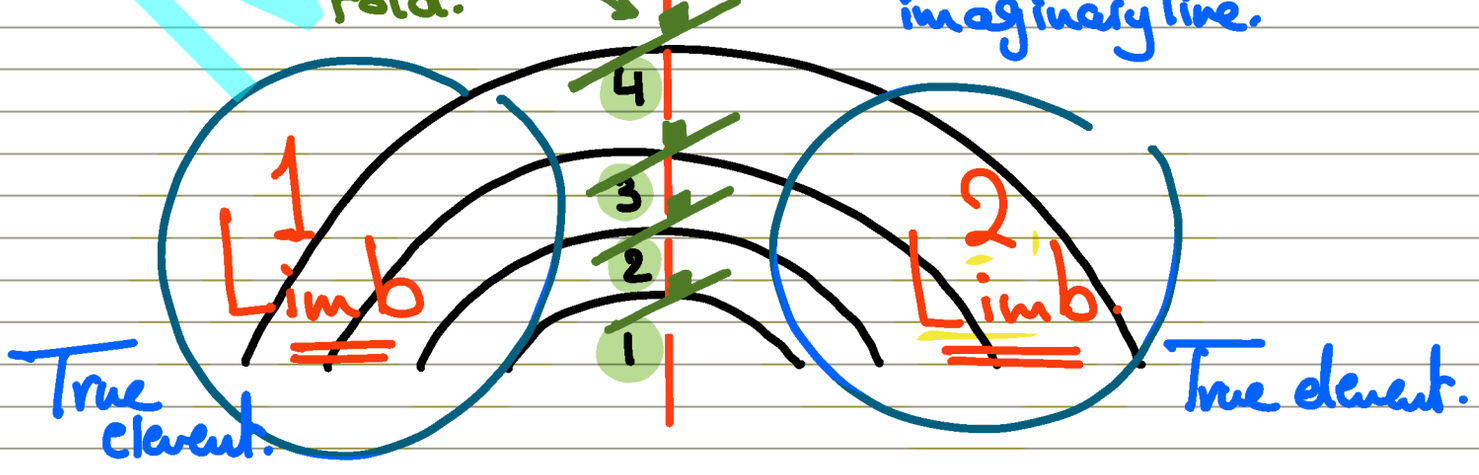
A Fold :-



pt :- Structural elements.

axis = No. of layers Fold.

axial plane = Fold.
imaginary line.



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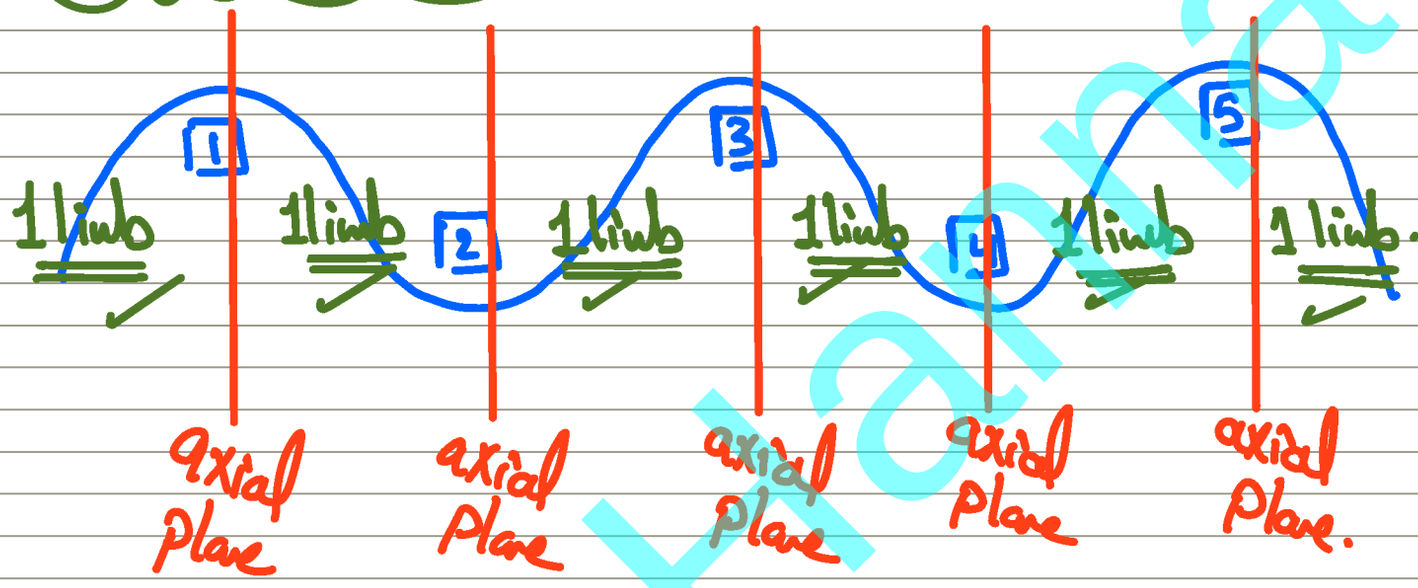
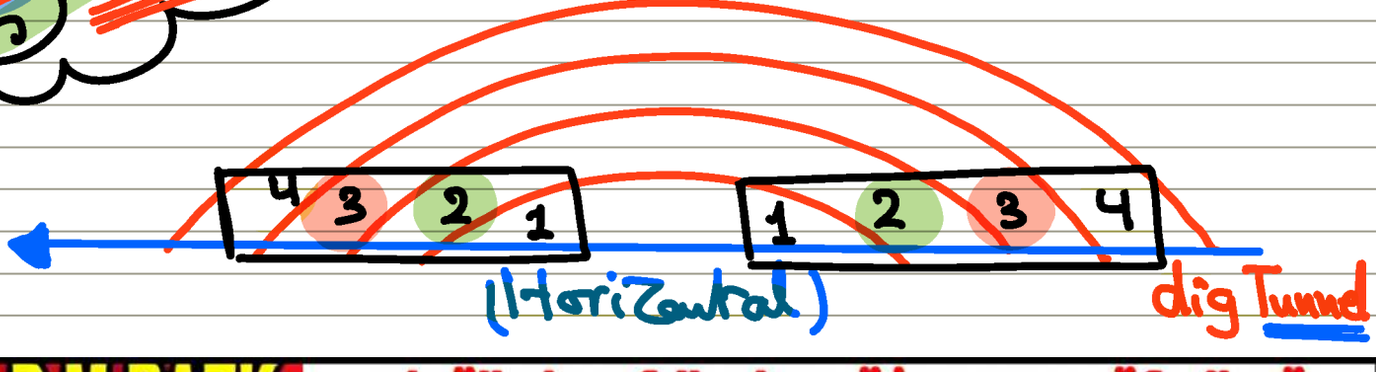
Simple Fold

∴
- 1 Fold = 1 axial plane.
- 2 limbs.
- Axis = No. of layers Fold.

Connected Fold



- 5 Fold = 5 axial planes.
- limbs = 5 axial plane + 1 = 6
- Axis = No. of layers x Axial plane



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Types of Fold

Anticline Fold.

قمة

فوق

Young — old — Young

في هي

Syncline Fold.

old — young — old

في لغي

(new) → less than 5million

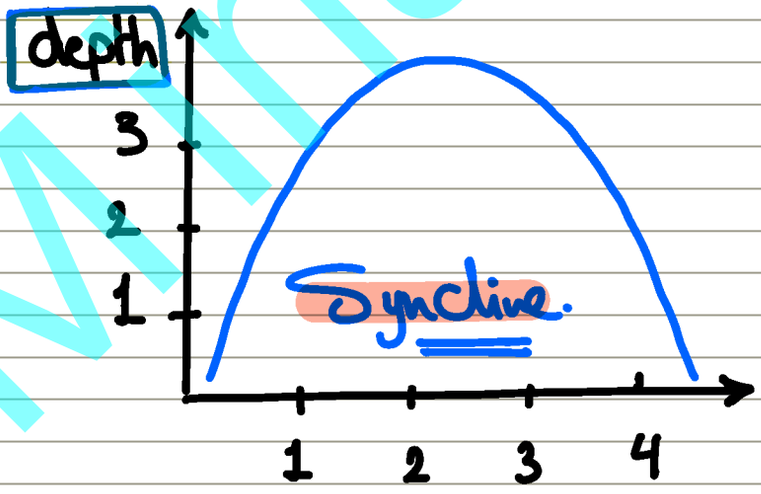
4
3
2
1

(old) → 5million

(new) → 3million

4
3
2
1

(old) → more than 3million



B Fault :: Fracture with displacement.

due to Compression or Tension

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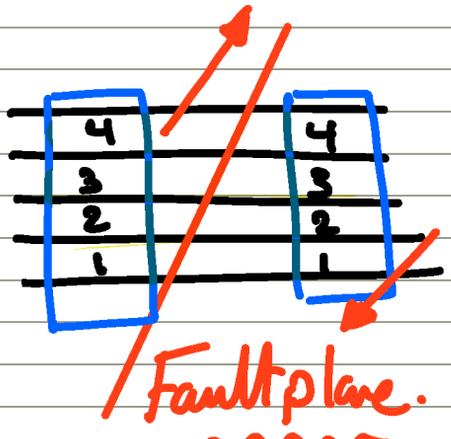
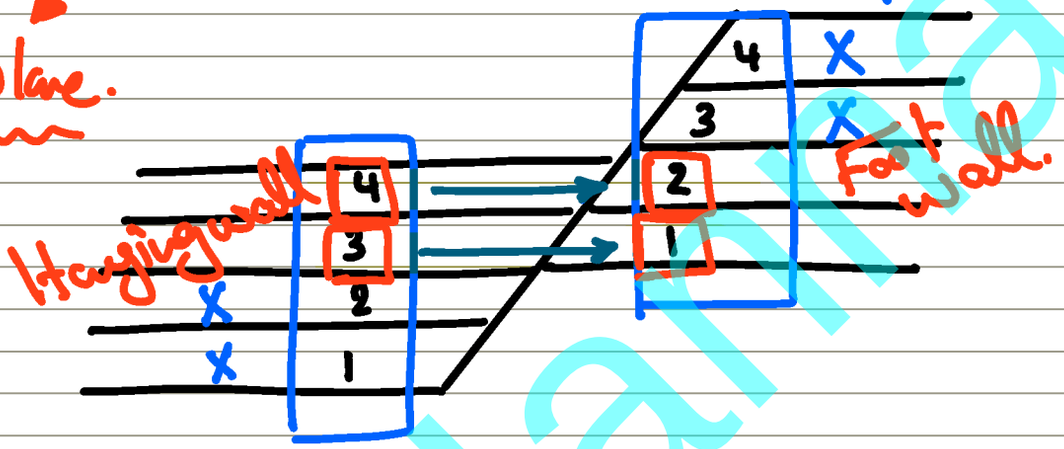
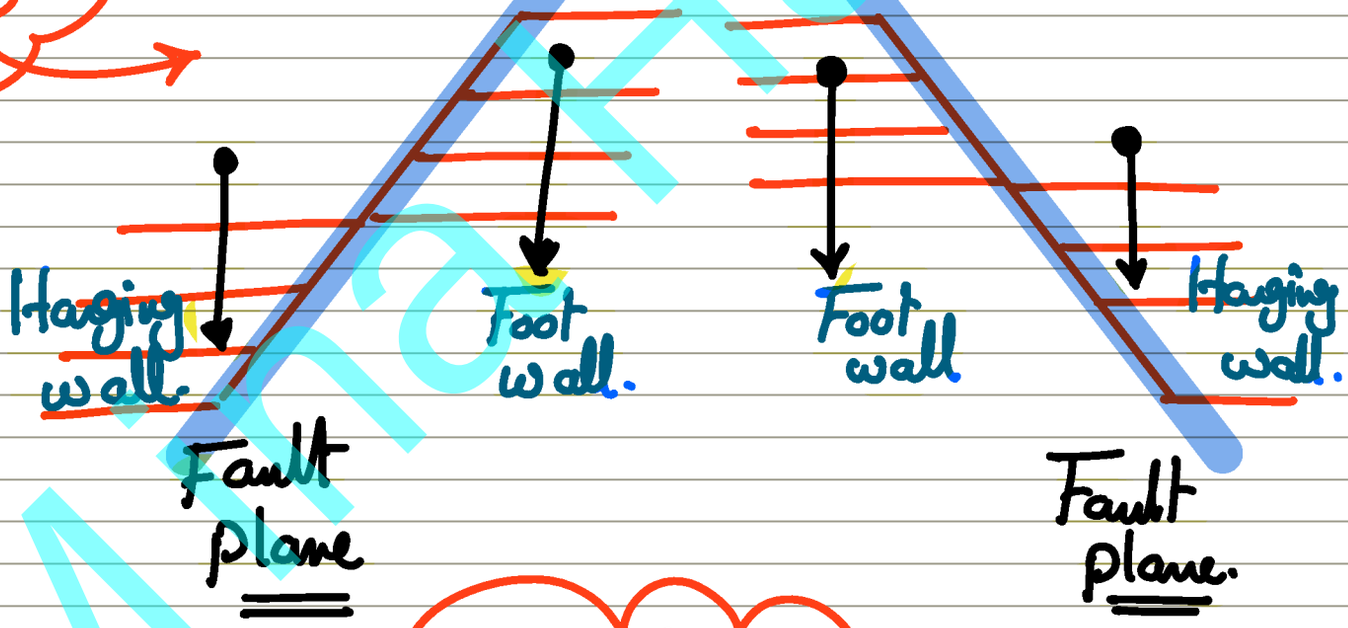
* Structural elements of Fault :-



1. Fault plane.
2. Hanging wall → Fault plane. على
3. Foot wall → Fault plane. تحت



فى بالك →



* Types of Fault :-

1. Simple Fault. :-

Normal Fault - Reverse Fault.
Thrust Fault - Strike Slip Fault.

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1 Normal Fault :- due To tension Force (قوى شد)

Hanging wall Fall down ward to the Foot.

∴ Normal Fault. ∴ Normal Fault.

Note :- Increase Surface area Causes losing of Some layers.

∴ No repetition in Normal Fault.

الكل الكبير: New layers of Hanging wall Faces

الشرح: old layer of Foot wall

2 Reverse Fault :- due to Compression Force (قوى الضغط)

Hanging wall moves up ward above the Foot.

"Z" أفتكر شيء حرف xxx

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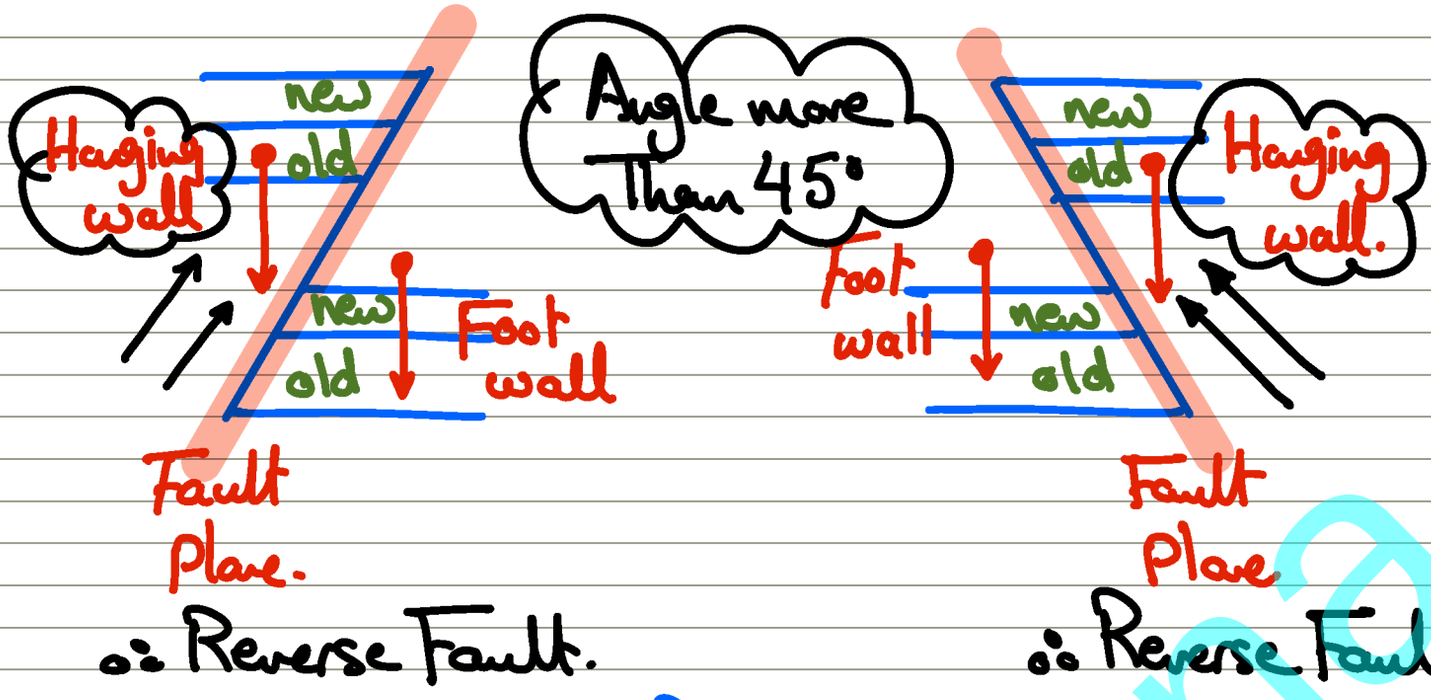
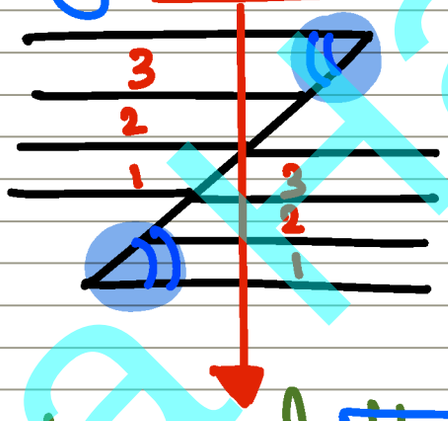


∴ Reverse Fault.

∴ Reverse Fault.

Note :- dec. surface area of Reverse Fault.

Causing **vertical** Repeatition.



No Horizontal Repeatition.

الكل

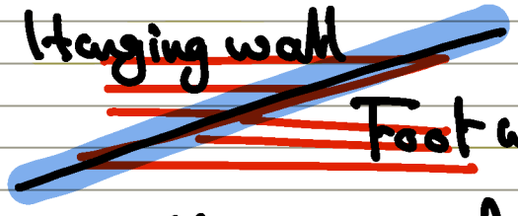
الجزء

old layers of **Hanging wall** Faces

New layer of **Foot wall**.

exception → Reverse نوع من

3 الحالات → Thrust Fault.



Hanging wall moves almost Horizontal

(angle less than 45°)

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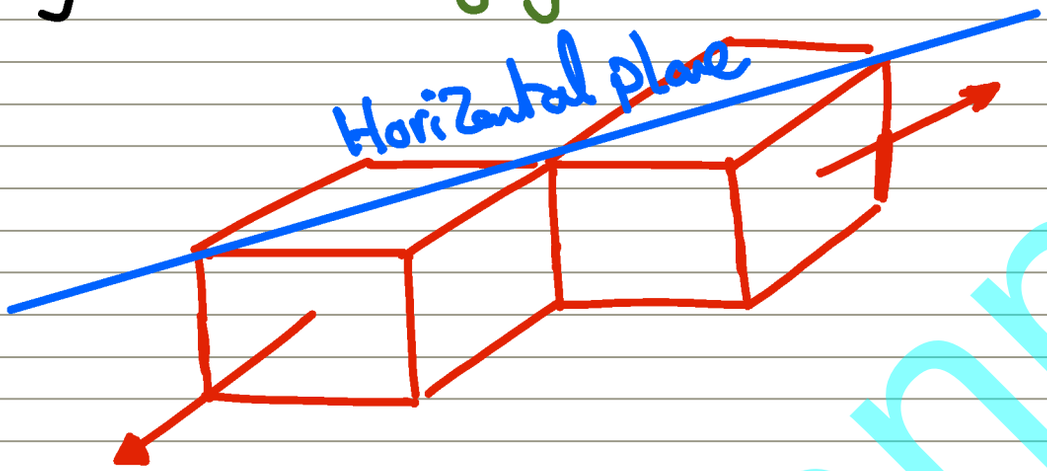
4 Strik slip. → Horizontal Repetition.

No vertical by Shearing Force بفعل

Similar to Fold مثل الثنية

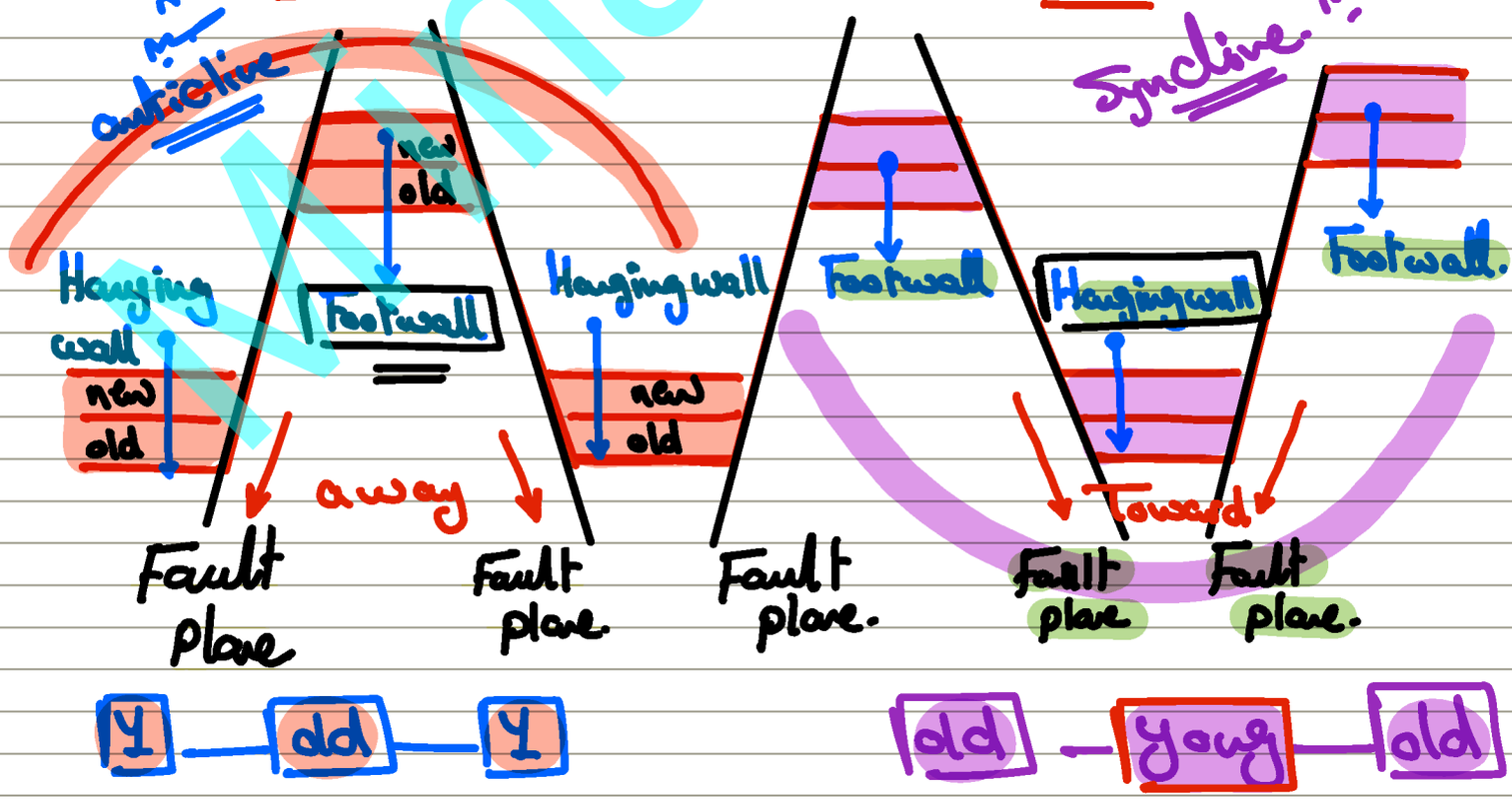
No Hanging nor Footwall



2 Gmpound Faults : "Normal Fault"

Forest Roof في نفس الوقت 5element

Garben. Hanging في نفس الوقت 5element.



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c Joints. :

Fracture without net displacement.

* Factors related to Joint.

xx No. of Joints ↔ distance bet. Joints.

① Type of Rock

Sedimentary → Joints inc. + distance small

Igneous / Metamorphic → Joint dec. + distance is large.

② Thickness.

Thick Rock → Joint dec + distance is large

Thin Rock → Joint inc. + distance is small

* unConFormity = (عدم التوافق)

D — disConformity

N — non-Conformity

A — Angular non-ConFormity.

#dependon Trangression and Regression of water with erosion & Non-deposition of layers.

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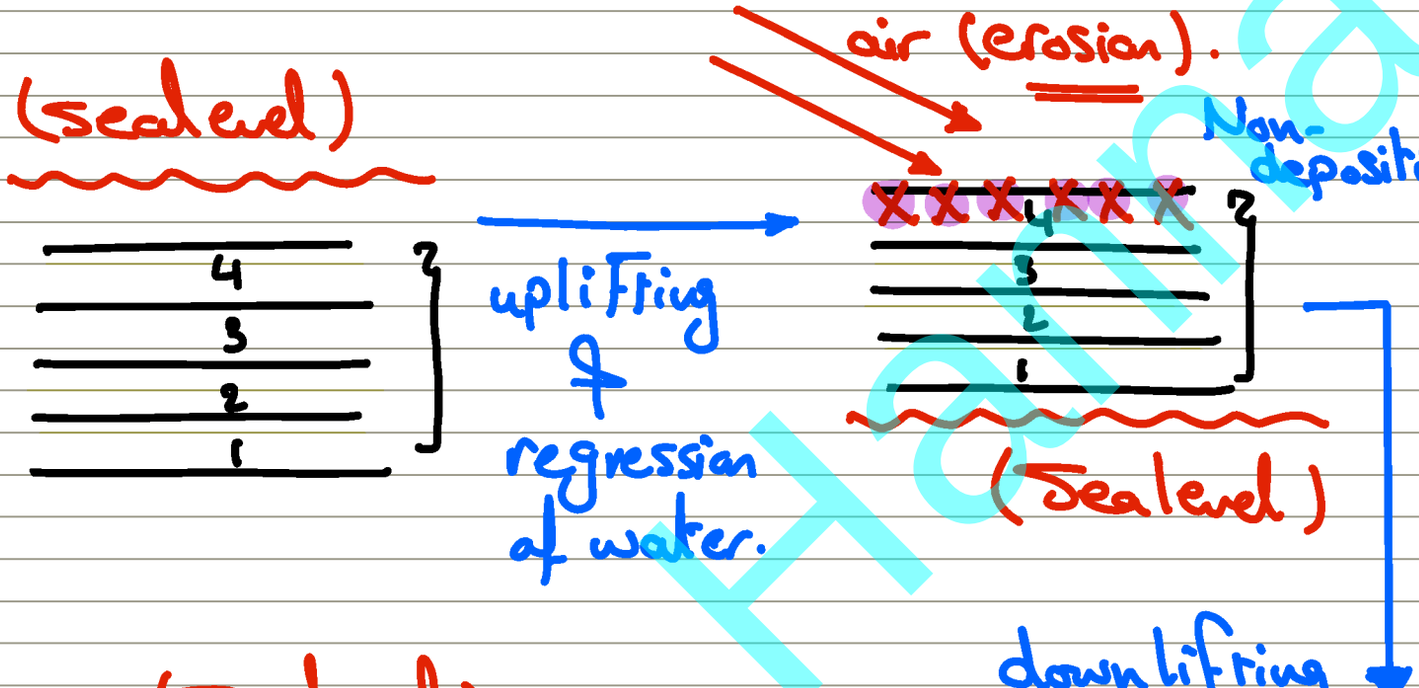
الفكرة

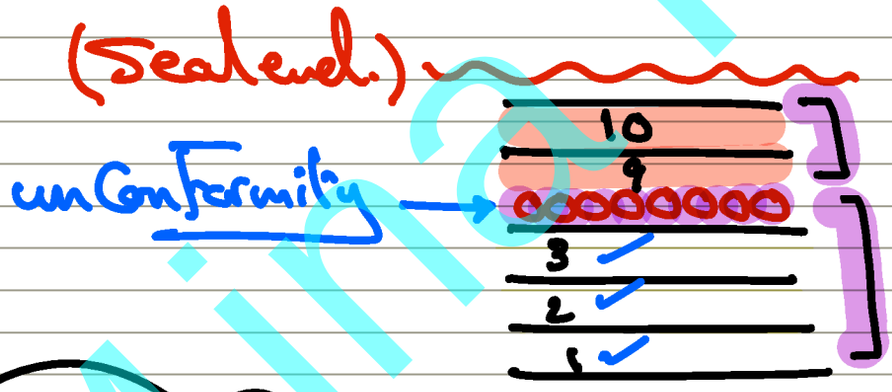
U - R - E → D T D

Millions of Years.

U: uplefting — R: regression — E: erosion & non-deposition

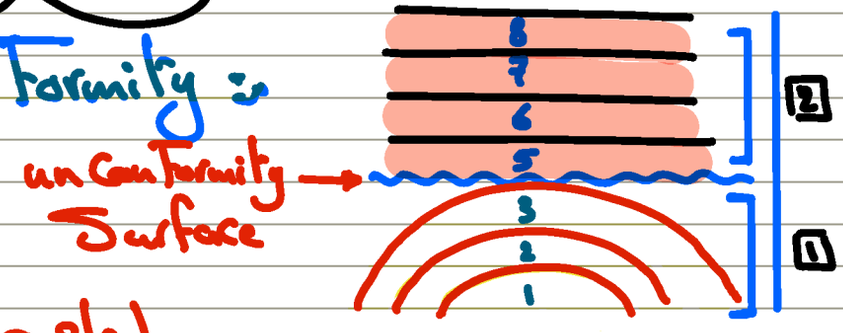
D: downlifting — T: Transgression — D: deposition





* Types of unConformity :-

1 Angular unConformity :-



1- deposition

2- Tectonic Force (dip angle).
(Compression - Tension)

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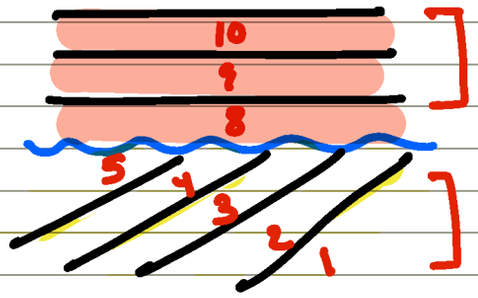
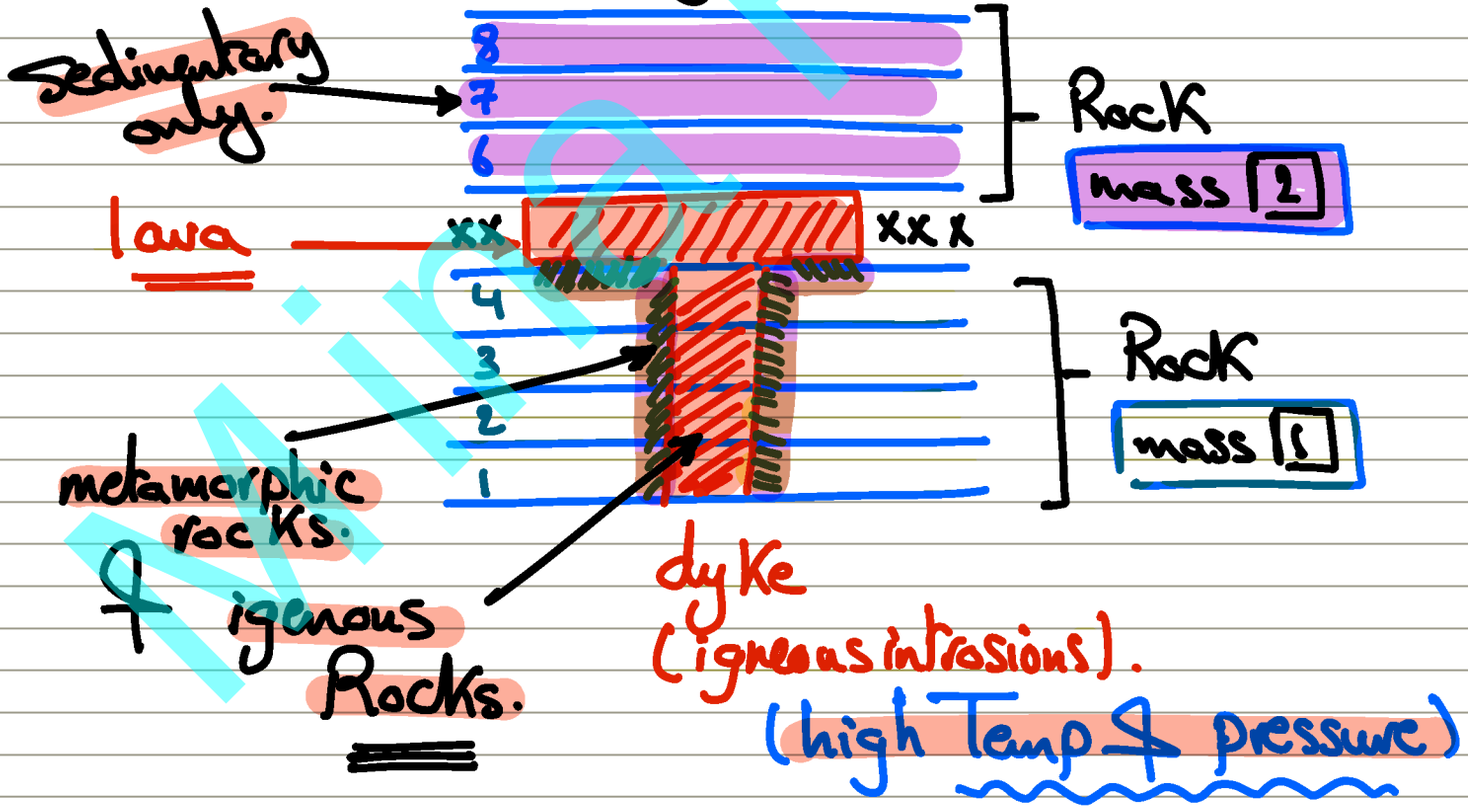
3- upliFting
4- erosion & Non-deposition.
5- downliFting
6- deposition.



Bet. 2 sedimentary rocks with different angles.

2 Non-Conformity

→ between 2 types of Rocks one is Igneous or Metamorphic while the other is Sedimentary (the Sedimentary layer is the Newest layer over the other Types).



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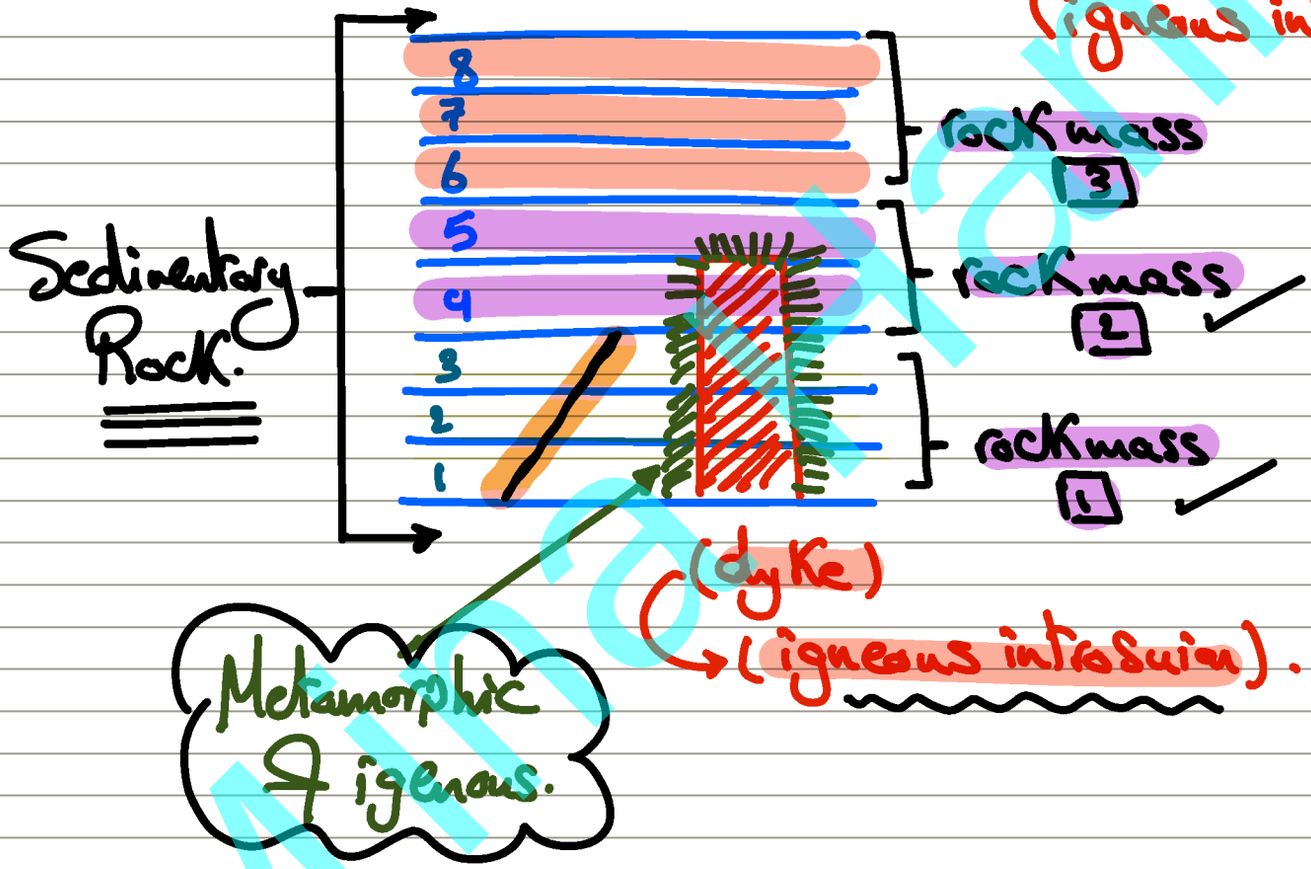
3 1. Dis Con Formity 2.

Bet. 2 sedimentary layers deposite with the Same agle.

ReFrence → Fossil record.
→ Geological structure. (ex: Fault).
→ Dyke & sill (igneous intrusion).



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Chapter two

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Introduction

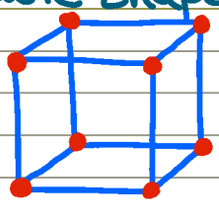
Atoms → Molecule → Mineral → Rocks.

elements. — Crystal Form → Mineral (Main Condition.)

Rocks: Igneous Rock, Metamorphic Rock, Sedimentary Rock

example:

Sodium (Na) + Chlorine (Cl) → NaCl (Cubic Shape) → Halite → Rock salt.



Human on earth surface. — أضافين كائنات حية ...

xx always uses Minerals Found on Earth's Surface

① used in Building or Agricultural.

② protect From natural distaers.

uses of Minerals

Paleolithic Man

* Chert (Flint): used in Formation of Knives & spears for hunting.
* Hematite & lemonite: used in Glowing and painting of Cave walls.
* Clay → (after discovery of Fire) → Ceramic Pots.

Aciet egyptian

use minerals in ornamentation & in Temples. as:

- Tourqouise
- malachite
- elemerade

Human (Now)

* Calcite ($CaCO_3$): Cement production
* Quartz (SiO_2): Glass Formation.
* Feldspar: Ceramic
* Hematite & magnetite: Steel.
* Diamond, Copper, Gold: Jewellery.

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Rocks

Minerals

Element.

Single Mineral. (معدن واحد)

ex: Halite → Rock salt.

ex: Quartez → Sand Stone.

ex: Calcite → lime Stone.

Compound Mineral (معادن مختلفة)

ex: granite (igenous Rocks).

Contain M - F - Q

(mica) (Feldspar) (Quartez).

elemental Mineral. (عناصر واحد) ⇒ Rare

ex: Gold (Au) - Copper (Cu) - Sulphur (S).

Compound Mineral. (عناصر كتير) ⇒ Most Common.

ex: Silicate (SiO_2)

Calcite ($CaCO_3$)

Halite (NaCl).

Define :: Mineral → Non-geologist:

Structural building unit of Rock.

Geologist. (5 points).

1. Solid (not liquid - Gas).
2. Inorganic (not orginated From plant or Animal).
3. Natural (not influenced by human).
4. definite Chemical Structure. → (تركيب محدد)

((May change Chemical structure to certain extent.))

5. destinctive (Constant) Crystalline Form. (شكل ثابت ومحدد)

The Crystal Form doesn't Change & Changes by changing Mineral.

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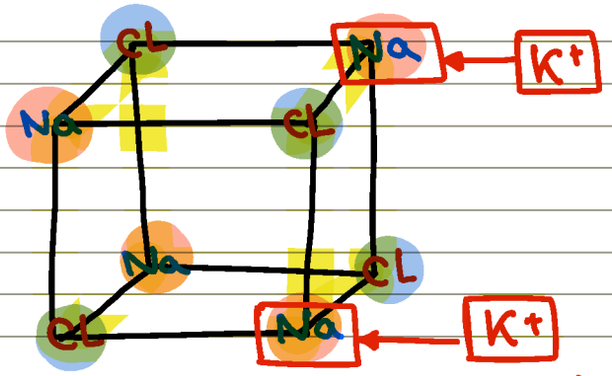
ex: Halite.

(Cubic Form)



Chemical structure.

"NaCL" → may change with very limited ratio.

another example → Graphite & diamond. both have Carbon in their Chemical Structure, but differ in Crystalline Form Causing different Minerals.

* Elements on earth's Surface:

↳ over 100 elements on earth's Surface.

98 elements. represent about 1.5% of Total on earth Surface.

8 Gmman elements represent about 98% of Total on earth's surface.

O	Si	AL	Fe	Ca	Na	K	Mg
oxygen	Silicon	Aluminium	Iron	Calcium	Sodium	Potassium	magnessium
46.6%	28.7%	8.1%	5%	3.6%	2.8%	2.6%	2.1%

* Minerals on earth Surface

↳ almost 2000 Mineral on earth's Surface.

90% 1800 mineral are abundant. (1/90)

(1/10) 200 mineral are Rare. 10%

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كل abundance يزيد ← كل economic importance تقل
(inverse relation)

* Gmman Minerals → عموم يا ١

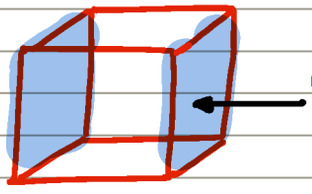
abundant

1. Silicate (Si+O) — 7
   - O olivine
   - P Pyroxine
   - A Amphibole
   - M Mica
   - F Feldsper
   - F Flint
   - Q Quartez
2. Carbonate (C+O) — 3
   - D dolomite.
   - M malachite
   - C Calcite
3. oxide (O) — 3
   - Hematite - Magnetite - lemonite (اكسيد)
4. Sulphide (S') — 3
   - Galena (البنت)
   - Pyrite (باجرة) (Fool Gold) الرخيص
   - Salphrite. (سالم)
   - GPS
5. Sulphate (So4) — 3
   - B Barite
   - A Anhydrite
   - G Gypsum.
6. Native element.
   - diamond, Gold, Gpper, Salphur, Siliver.
   - "elemental Mineral"

Rare

High economic Importance

* Crystal
  - Solid geometrical structure that have a crystal Face.



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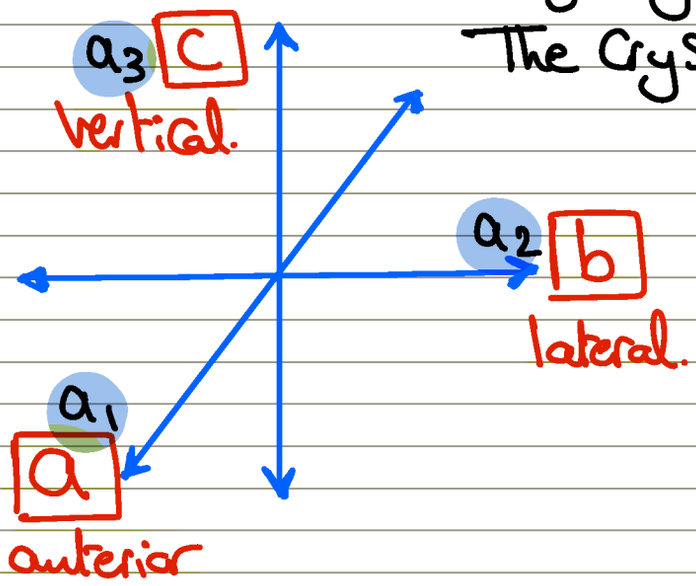
Chapter خاص بالـ دة الكم فى الجزء الـ

Structural elements of Crystal

1 Crystal axis: Imaginary line passes through center of The Crystal.



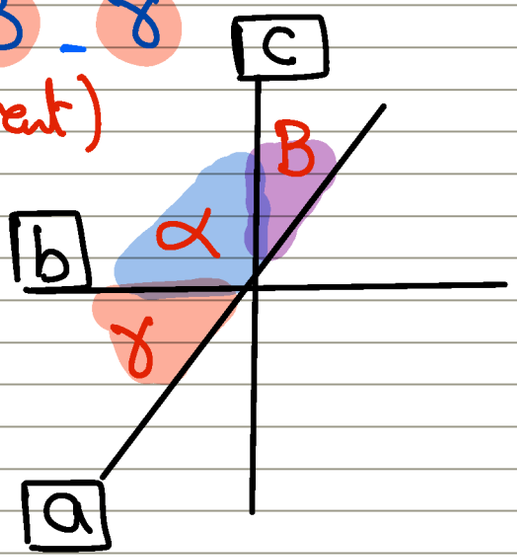
$$a \neq b \neq c$$
$$a_1 = a_2 = a_3$$

2 Angle between Axes. angle bet. any of 2 Axis.

3 angles which are γ - β - γ

(May be equal or different)

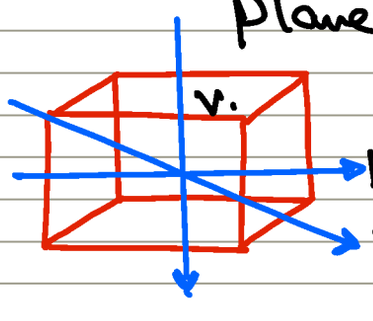
α (b-c) (a_2-a_3) - β (a-c) (a_1-a_3) - γ (a-b) (a_1-a_2).



3 Crystal plane of Symmetry

Plane that divide the crystal into 2 identical halves

(vertical - horizontal - inclined)



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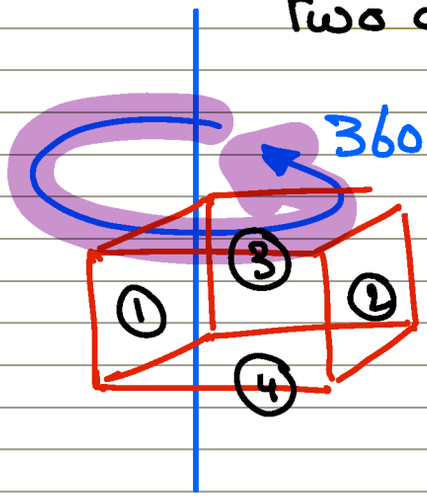
4 Crystallographic axis or axis of Symmetry :-

Imaginary line passes through the center of crystal where the crystal rotate around it with 360° causing Repeating of crystal faces or vertics or angles two or More times.



Type of Crystal :-

3	2	2
3 axis	3 axis	4 axis
$\alpha = B = \gamma$	$\alpha \neq B \neq \gamma$	
مكعب	مائل	

1 Cubic "مكعب"

- Crystal axis → $a_1 = a_2 = a_3$
- Angle bet. axes → $\alpha = B = \gamma = 90°$ (perpendicular to each other)
- Crystal plane Symmetry → "Most Symmetrical" → vertical, Horizontal, Inclined
- axis of Symmetry → 4 Faces each at 90°

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2

Tetrahydral

Crystal axis → $a_1 = a_2 \neq C$

Angle bet. axes → $\alpha = B = \gamma = 90°$ (perpendicular each other)

Crystal plane of Symmetry → vertical, Horizontal.

axis of Symmetry → 4 Faces repeated. 90°

3

orthrombic.

Crystal axis → $a \neq b \neq C$

Angle bet. axes → $\alpha = B = \gamma = 90°$ (perpendicular to each).

Crystal plane of Symmetry → vertical, horizontal.

axis of Symmetry → 2 Faces every 180°

→ Cubic & Tetrahydral & orthrombic Can be differentiated by Crystal axis while They have in Common the Same angle bet. Crystal axis.

$\alpha = B = \gamma = 90°$

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4

Monoclinic

نظام أحادي الميل

Crystal axis → $a \neq b \neq c$

angle bet. axes → $\alpha = \gamma \neq \beta$

$\because \alpha = \gamma = 90°$

$\because \beta \neq 90°$

خاصل في واحدة عاوية

Crystal plane of Symmetry → vertical only.

(only Crystal have 1 plane Symmetry)

Most abundant Crystal Form in Minerals on Earth.

axis of Symmetry → No axis of symmetry.

5

Triclinic

ثلاثي مائل

Crystal axis → $a \neq b \neq c$

angle bet. axes → $\alpha \neq \beta \neq \gamma$

Crystal plane of Symmetry → No plane of Symmetrical.

axis of Symmetry → No axis of Symmetry.

ثلاثي مائل → Mono Clinic & Tric linic Can be differentiated by angles bet. axes, while they have in Comman different Crystal axes.

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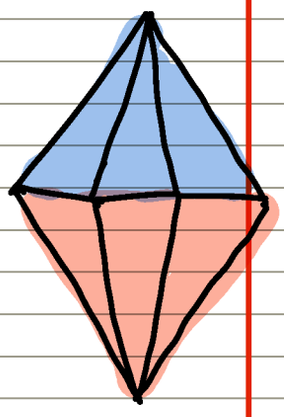
6

Hexagonal

Crystal axes :- → 4 axes.

3 horizontal 1 vertical.

$a_1 = a_2 = a_3 \neq C$



angle bet. axes → Horizontal bet. a_1, a_2, a_3 Angle 120°.

→ vertical → angle 90°

Crystal plane of Symmetry → 7 planes.

6 vertical + 1 Horizontal

axis of Symmetry :- 6 Faces every 60°

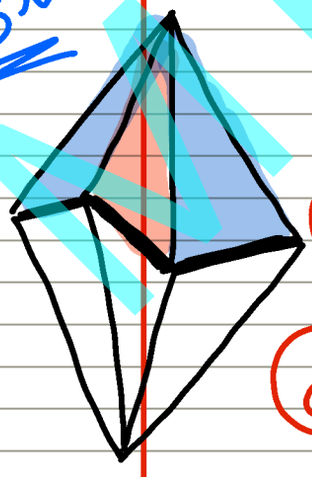
7

Trigonal

Crystal axis → 4 axes.

3 horizontal 1 vertical

$a_1 = a_2 = a_3 \neq C$



Crystal plane of Symmetry → vertical only

axis of Symmetry 3 Faces at 120°.

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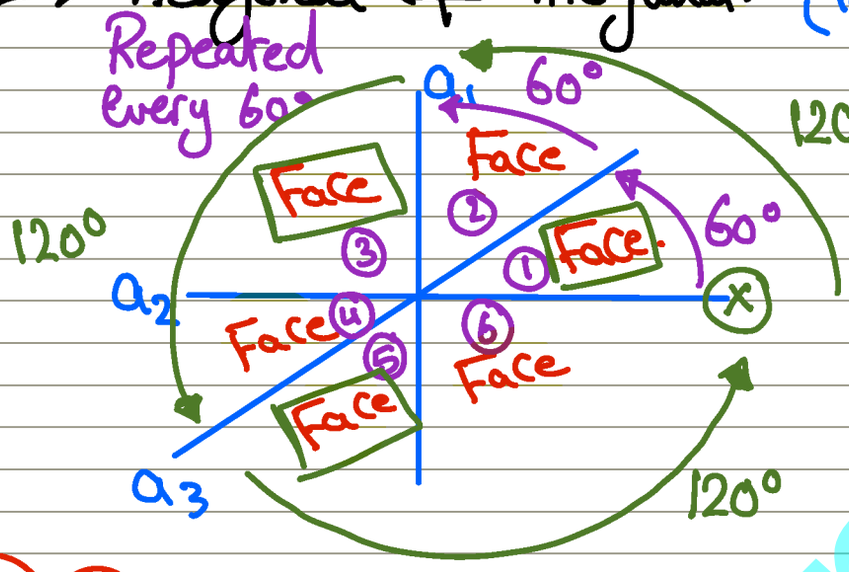
فاتك بالك → Hexagonal & Trigonal. (Top view)



Quick Recap → ملخص سريع

Crystal	Crystal axis	Angle bet. axes	Crystal Symmetry plane	axis of Symmetry.
Cubic.	$a_1=a_2=a_3$	$\alpha=\beta=\gamma=90°$	vertical, horizontal inclined.	4 times 90°
Tetrahydral	$a_1=a_2\neq c$	$\alpha=\beta=\gamma=90°$	vertical, Horizontal	4 times 90°
orthrombic	$a\neq b\neq c$	$\alpha=\beta=\gamma=90°$	vertical, horizontal	2 times 180°
Monoclinic	$a\neq b\neq c$	$\alpha=\gamma\neq\beta\neq 90°$	vertical	No.
Triclinic	$a\neq b\neq c$	$\alpha\neq\beta\neq\gamma$	No.	No.
Hexagonal	$a_1=a_2=a_3\neq c$	—	7 symmetrical plane.	6 times 60°
Trigonal	$a_1=a_2=a_3\neq c$	—	3 symmetrical plane.	3 times 120°

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* Physical properties *

A optical properties

Relation between **incident light** on the **Mineral** and its reflective Surface.

1 lustre (لمعان) Related to Reflection of light by Mineral.

a Metallic lustre	b Non-Metallic lustre.
Resemble Metals that reflect most of light.	① Glassy (vitrious)
ex: Galleng (الجالينا)	ex: Calcite ($CaCO_3$) - Quartez (SiO_2)
Pyrite (البايريت)	② Pearly ex: Feldspare.
Gold. (الذهب)	③ Dull / earthy (ترابي)
	ex: Kaolinite. (الكاولين)

2 Colour (الألوان)

Colour of Mineral is less usefull in determination The mineral. ☹

① due to presence of impurities that Can Change the Colour of Mineral as in Quartez.

① due to limited replacement of Chemical elements in the Chemical structure of the Mineral without Changing the Crystal Shape as in Sulpharite.

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example :- **A** Changable Colours in Mineral.

Quartez → SiO_2 + □

1. Transparent (Pure quartez) → Rock crystal.
2. Rose quartez (pink) → Manganese impurities.
3. Amthyst (Purple/violet) → Iron oxide impurities
4. Milky (white) quartez → Gases Trapped.
5. Grey (dark) quartez → breaking of Certain Band due to Radioactivity.

Sulphurite → "ZnS" Zinc sulphide.

Yellow Transparent → Change to Brown due to replacement of Iron to Zinc, but the Crystalline Shape remain Constant.

B Constant Colour of Mineral.

* Sulfur → Native element is Yellow Colour.
* Malachite → hydrous $CuCO_3$ is Green Colour.

3 Play of Colour :- (تلاعب الالوان)

Releated Change of Colour by Changing the angle infront of You.

Ex : ① Diamond → Red & violet Colour.
② opal → Cat eye.

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4 **Streak** (الخدش) :-

important way to determine the Mineral.

→ Streak of Mineral is Constant.

ex :- * Hematite (iron + oxygen) → Red.
(dark gray or red)

* Galleneu. → Black
(Golden Yellow)

* Quartez → White
(different Glow)

5 **Transparency** :- (مدى الضوء)

Transparent - Translucent - Opaque.
شفاف — شبه شفاف — معتم

B **Cohesive properties**

Related to properties of Mineral under stress.

1 **Hardness** :- (الصلادة)

Resistant of Mineral to scratch.

Idea :- relatively determined when a harder Mineral scratch a weak Mineral (softer).

Moh's scale → (1 → 10)

determine hardness of different Mineral.

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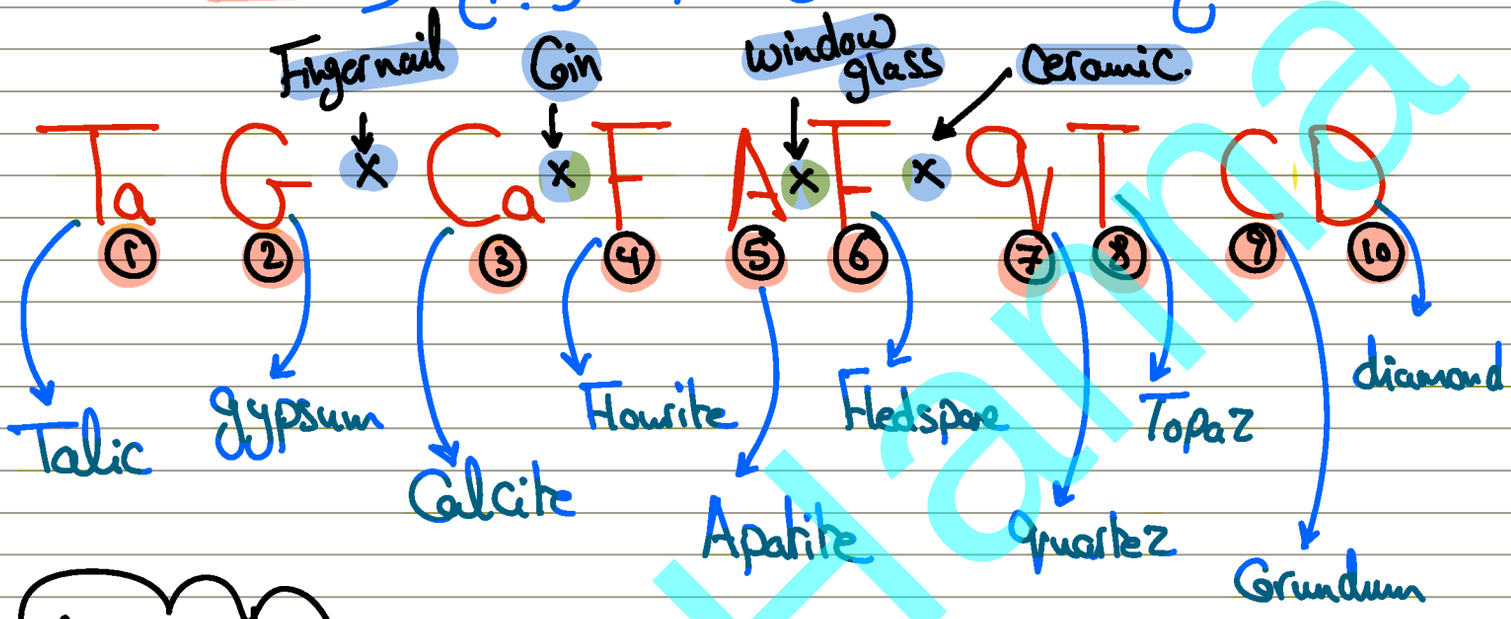
* to differentiate :: (التفرقة)

↳ orginal Natural gem Stone → Stronger (than 7.5).

↳ artificial gem Stone → weaker (less 6).

* Moh's Scale *

مقياس موهس للزجاج و الاظافر



Applications ::

1. Alloy ذات → "Hardness Pen" (1-10).
(determine unKnown mineral)

2. Common Material → Known hardness.

Finger nail → 2.5

Coin → 3.5

piece of window → 5.5

Ceramic piece → 6.5

Hardness

2. Cleavage (انشقاق) → (شبه التورنة)

Idea → Mineral is split along weak planes.

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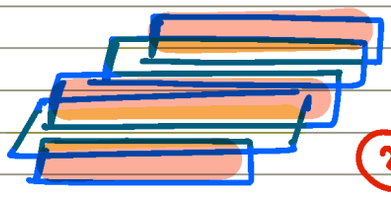
or (weak bands) due to Stress or pressure resulting a smooth surface (ناعم)

Types :-

A cleavage in one direction :-

example :- ① Fleaky cleavage (رفيعه لبه)

ex: Mica Sheets.



② Basal cleavage (قاعدي)

ex: Graphite.

(Parallel to the Base)

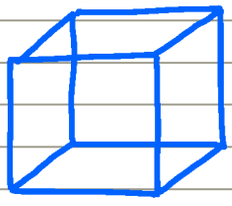
B cleavage in Many directions :-

(3 direction) (اتجاه)

example :-

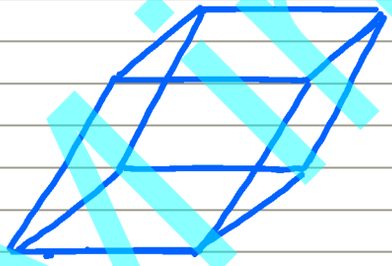
① Cubic (90° degree) مكعبي

ex : Halite - Galena.



② Rhomohydral (≠ 90° degree) معيني

ex : Calcite.



3 Fracture. (الكسر) → No cleavage

Cleavage ماقدرش ماقدرش weak plane.

∴ Fracture تتكسر

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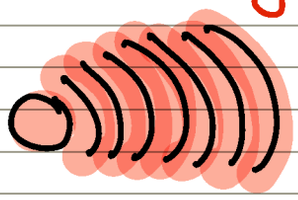
Idea → Surface (structure) result from break of Mineral rather than cleavage plane.

ex: Conchoidal fracture.



example : Quartez.
Flint (Chert)

4 Melability & ductility : "التشكيل"
Reshape of Mineral by hammering of Metal.

ex: Copper - Gold - Silver.

C other properties :

1 specific gravity (density) تثبيه الـ

$$\frac{\text{Mass of any Mineral.}}{\text{Mass of water}}$$

Same volume

example
Mass of Gold (1 litre) → 19.3 Kg.
Mass of water (1 litre) → 1 Kg.
∴ specific gravity Gold = 19.3

Another example ∴ specific gravity Galena = 7.5

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2 Magnetic properties :-

attracted to Magnet

ex: Magnetite ✓ hematite ✗.

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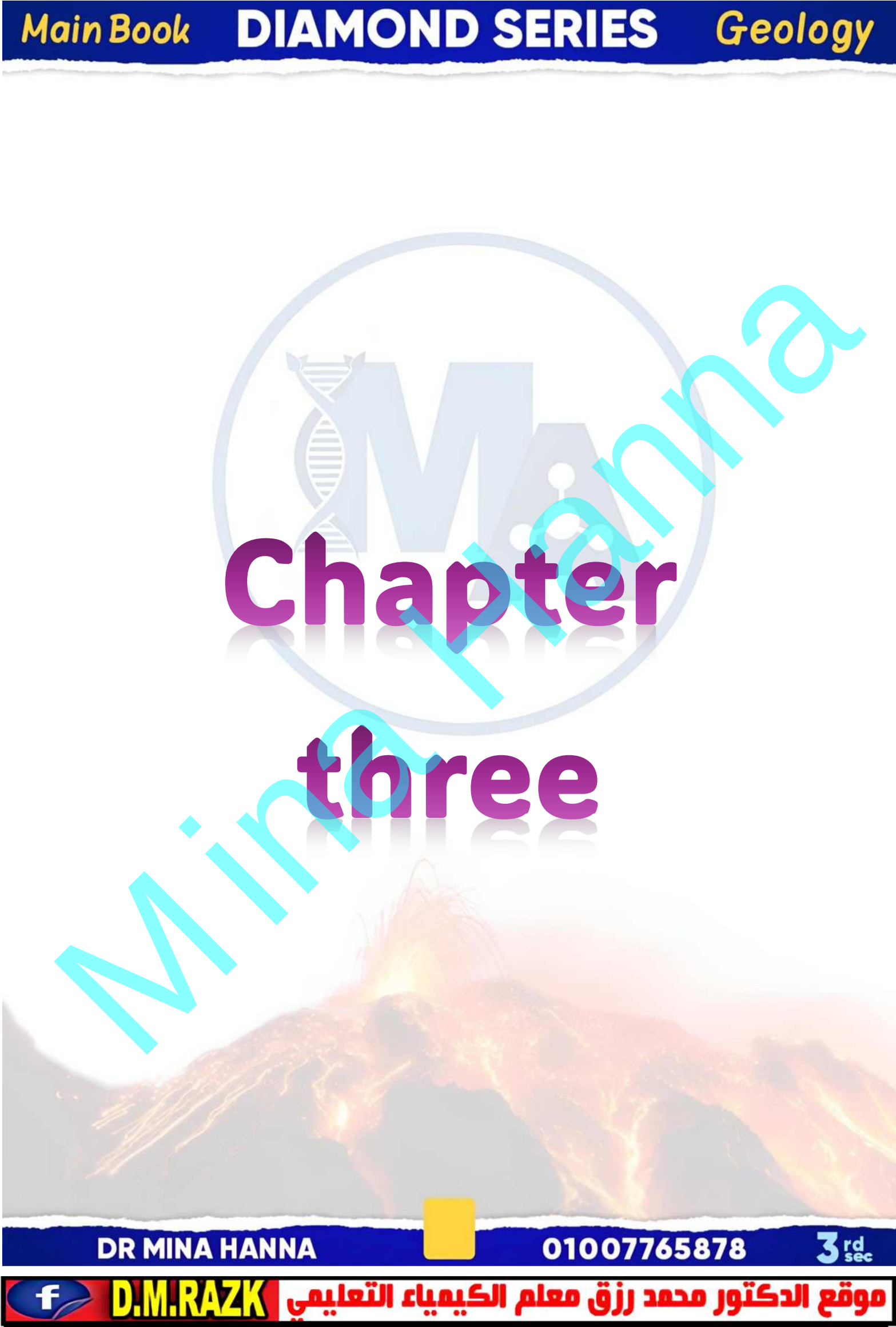
Chapter three



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Chapter Three: Rocks.

Recap.

Chapter one: Earth's Crust Contain three Types of Rocks (igneous - Sedimentary - metamorphic).

Chapter two: Rock (وتتكون) → Minerals (وتتكون) → elements.

(Natural - Solid) — (Conditions For minerals.) 5 Conditions.

Chapter Three ..... بقى بقى

You have 2 Main Types.

A Primary Rocks → (صخور أولية)

Many Billions Years ago, The earth was Covered by Molten materials (high visicous liquid Contain many elements). → after some Time, it started Cooling and Solidified (Crystalized) to Form.

Igneous Rocks "Mother of all rocks"

B Secondary Rocks. → (صخور ثانوية)

Fragmentation & deposition → Sedimentary Rock.

Heat & pressure → Metamorphic Rock.

Compare between Types of Rocks :-

1 way of Formation 2 properties 3 example.

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Point	Primary rock	Secondary rock.	
Point	Igneous rock	Sedimentary rock	Metamorphic rock.
way of Formation	1 Cooling 2 Crystallization (Solidification). ions gathering around Center of crystal. تكون بالك من انواع Igneous Rocks. بتعتمد على 1 rate of Cooling. بطئ — بسرعة Lava — Magma. 2 Crystallization Temperature. high Temp. 1200 c° — low Temp. 750 c°	1 Fragmentation (weathering) Physical (تكسير) — chemical. (تفاعل) 2 Transportation (erosion) by air - water. 3 deposition. (ترسيب) Bedding. 4 Consolidation Pressure = التماسك (Pressure)	1 increase Temp. (Heating) 2 increase Pressure. (Melting مش لدرجة) Igneous rock. تكون 3 increase Temp. & Pressure. (Change properties) New Characters.
properties	1 Crystalline Shape (كريستال) 2 Non-porous. (عشان Gases تهرب) 3 Massive (كتلة) 4 absence of Fossil. (لان Fossil يتلف)	1 Rarely Crystalline ex: Halite = Nacl. 2 Porous (Gases). مخازن لبعض (precious minerals) 3 Bedding (layers) (Stratified) 4 Presence of Fossil	1 Crystalline 2 Non-Porous. 3 May be Massive (لو بلعب على حرارة) or Foliated (بطئ) (حرارة و ضغط) 4 destorted Fossil.

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Types of Rocks : A. Igneous Rocks.

xx way of Formations.

A Cooling (التبريد) (dec. Temp) ↓↓

B Crystallization or Solidification (التشكيل)

Molten material ⟶ Rocks.

∴ Minerals (ions) gather around Crystal center.

الكائنات الأولى ⟶ elements ⟶ Minerals ⟶ Igneous rock.

8 — 6

Molten rocks (Material) المصهور

vicious liquid at high Temperature Contain different elements Known as lava or Magma.

سائل لزج على حرارة عالية — ذوبان بين الصخور

8 elements (Chapter two).

O - Si - Al - Fe - Ca - Na - K - Mg.

oxygen — Silicon — aluminium — iron — Calcium — Sodium — Potassium — magnessium

Contain other gases (ex: water vapor.

كمية كبيرة من البخار بسبب الضغط والحرارة

سؤال: ازاى elements ← Crystallization then Minerals.

xxxx أول واحد درس Igneous Rocks عالم اسمه Bowmen

قدم شرح Crystallization reaction و Bowmen's reaction

xx فاكى بالك ؟!

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Conclusions:

1 في نقط Solidification بيبقى Minerals كل من
الوقت ... عشان كل Mineral عندة أنواع وعنصر element

2 Mineral اللى عندة elements في High melting point
Solidification الأول ← High density وكمان

3 Mineral اللى عندة elements في low melting point
Solidification later. ← low density وكمان

Mineral 50% → Fe - Ca - Mg (Solidification at high Temp.) ← الأول

Mineral 50% → K - Al - Na وأخيرا SiO_2
(Solidification at low Temp.)

English. = Fe Ca Mg (50%) K Al Na (50%) Si (أخيرا Si)

الغرب → Mg Ca Fe - NaALK - سيليكون Si

Conclusion →

1 First Crystallized Minerals that rich with Fe. Ca. Mg.
2 after 50% of Magma Crystallized. the remaining Minerals Contain K. AL. Na Crystallize.
3 at end the Conc. of Silicon inc. gradually.

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Bowmen's Reaction

Two sides. ← Crystallization reaction → مع

Left side (متقطع)

(discontinous Series)

- Olvine
- Pyroxine
- Amphibole.
- Mica.
  - Biotite

diff. Mineral (مختلف) Crystal system.

Right side (متصل)

(Continous Series)

Feldspare

Crystal system. نفس

element العنصر

- Ca^{++} → Plagioclase Feldspare
- Ca^{++}/Na^{+} → Plagioclase Feldspare
- Na^{+} → Grid Feldspare.

high Temp. 1200c°

low Temp 750c°

- orthoclase feldspare. (K^{+} Feldspare)
- Muscovite Mica
- Quartez.

Total → 6 Mineral. From high Temp. → low Temp.

O - P - A - M - F - Q

- O: Olvine
- P: Pyroxine
- A: Amphibole
- M: Mica
  - Biotite
  - Muscovite.
- F: Feldspare
  - Plagioclase
  - orthoclase
- Q: Quartez

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* Classification of Igneous Rocks :-

(حسب)

Rate of Cooling. (سرعة التبريد)

- plutonic rock (عميقة) (below - deep).
- intruded rock (في نفي) (near to surface)
- volcanic rock. (على) (at surface)

Crystallization Temp. (درجة الحرارة)

- ultra Basic → ultra Mafic 1200c°
- Basic → Mafic 1100 c°
- intermediate 900c°
- acidic → Felsic. 750c°

A Place of Crystallization

depend on rate of Cooling.

1 plutonic igenous Rocks :- (داخلي) باطنية

Way of formation :-

يتبرد ببطئ شديد جدا
مدفونة في طبقات القشرة
بيانات وقت كبير وبتشكل كرستال كبيرة

Slow Cooling as Magma buried at great depth in earth's crust, where ions and elements gather around center of Crystals Forming large Crystals.

Texture / properties.

حجم كرستال كبير وحدة قليل

Coarse Texture, as it Contains large crystals that Can be seen by naked eye. and Fewer in no.

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2 intruded igneous rocks متداخلة (صخور نارية)

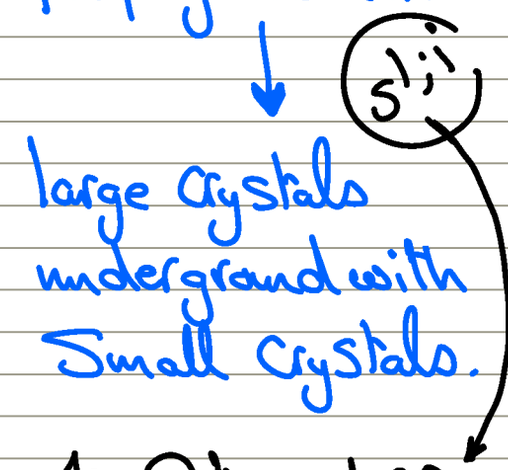
Way of formation :: Magma قريب من السطح ولمبرد أسرع ولتكونه متوسطة

Magma rise near to the surface and intruded between different layers.

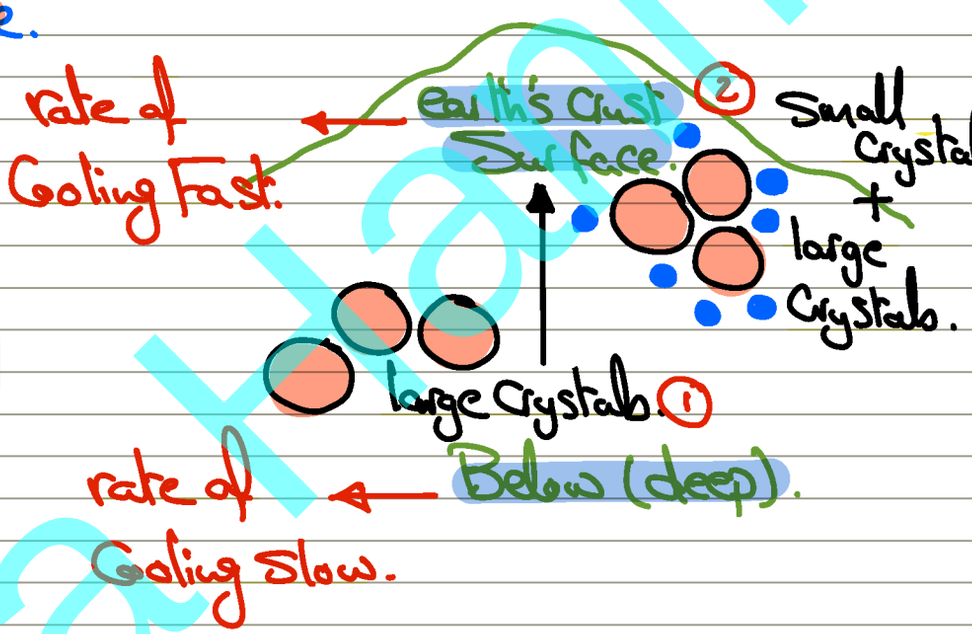
Texture / properties :: كريستال متوسطة بتتكون من تبريد وتبلور في نفس وقت

Porphyritic Texture.

large crystals underground with small crystals.



على Cooling Deep مرحلتين؟!



3 volcanic (extruded) igneous rocks :

Way of formation :: Magma على شكل lava بتخرج بسبب volcanic eruption على سطح Crystal. مكنش ليها وقت فبتكون Crystals صغيرة جدًا أو ملهاش

Take very short time for crystalization, as lava exit from volcanic eruptions. (very rapid Cooling).

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Texture / properties

- كريستال لغير أوى
- ماعندش كريستال أصلا "Not"
- ممكن تكون ماسى

Maybe :- Fine Crystals - Glassy - Fourthy.

↓ very small Crystal ↓ No crystals ↓ Gases جت ملامسة على سطح

Recap :- عوم لبن

Point	Plutonic	intruded	Volcanic.
Site of Crystallization	very deep	Near to the Surface.	at surface
speed of Crystallization	very slow	Slow at deep first then Fast at near Surface.	very Fast
Rock Texture	Coarse.	Porphyritic.	- Fine - Glassy - Forthy.
Size of Crystal	large size	large size underground with Small size	Small or Absent.
Number of Crystal	Few	medium.	Many.

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B Classification according to Mineral Composition

depend on Crystallization Temp.

Point	(ultra basic) ultramafic	(Basic) mafic	intermediate	(acidic) Felsic.
Temp	1200 c°	1100 c°	900 c°	750 ≈ 800 c°
	increase ← Fe - Ca - Mg. (high melting point) → decrease			
		iron Calcium Magnessium		
	decrease ← K - AL - Na (low melting point). → increase			
		potassium Aluminum Sodium.		
Silicon	< 45%	45% - 55%	55% - 66%	> 66%
	decrease ←			→ increase
Colour	Black	Black	grey	light pink
	darker ←			→ lighter
density	higher	high	intermediate	lower
	increase ←			→ decrease.
Mineral	(ب ا) Olvine, Pyroxene	(ب ا) Olvine, Pyroxene, Amphibole	(ب ا) Pyroxene, Mica, Feldspare "orthoclase", Amphibole, Quartez	(ب ا) Mica, Feldspare "orthoclase", Amphibole, Quartez
	pligeoclase Feldspare →			
	Ca^{+} Feldspare	Ca^{++} Feldspare	Ca^{++}/Na^{+} Feldspare.	Na^{+} Feldspare

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volcanic	Komatite كوماتوت	Basalt بازلت فوق	Andisite انذى فوق	Rhyolite رايا Fine. Pyomice بيومى Forthy obsidian. كلاسيه Glassy.
intruded	X مافيش intruded.	dalirite دولى ني نيت	Micro diorite. ميكرو دايو نيت	Micro granite ميكرو جرانيت
plutonic.	peritide. بيرى نيت	Gabro جابرو نيت	diorite دايو نيت	Granite جرانيت نيت
ultramafic رايا كوبرى Ko Pr	Mafic. Basit وجابرو ودولى	intermediate عنى ما بين عريه Dea بعنها وليت Micro ___	Felsic. رايا وبوتاسيومى جابين كلاسيه نزاز وقلت اكسرت opss... نازلين جرانيم ميكرو وكين	

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* equivalent igenous rocks *

Same chemical structure and Save Crystalization Temp. but differ site of crystallization, rate of Cooling and Size of grains.

xxx Crystallization Temp :: elements - Minerals - density (1200 - 1100 - 900 - 750°) Colour - Melting point.

xxx Rate of Cooling :- (Fast - Slow)

Texture - Site of Crystallization
Number - Size

Recap

Point	1200c° ultramafic	1100c° mafic	900c° intermediate	750c° Felsic.
Volcanic	Komatite	Basalt	Andisite	Rhyolite Pyomice obsedian
intruded	—	Dolirite	Microdiorite	Microgranite
plutonic.	Perioride	Gabro	Diorite.	Granite

Geological structures of Igneous Rocks in nature.

Section with Chapter 1

- extruded volcanic. (خارجية)
  - lava flow سائل بعد ما يتثنى
  - volcanic pyroclastic. Ashes / Breccia.
  - volcanic Bombs. كتل كبيرة massive
- intruded plutonic. (داخلية)
  - Batholith. منفذ
  - Dome القبة
  - lopolith / laccolith.
  - Dyke قاطع
  - Sill موازى

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A intruded plutonic.

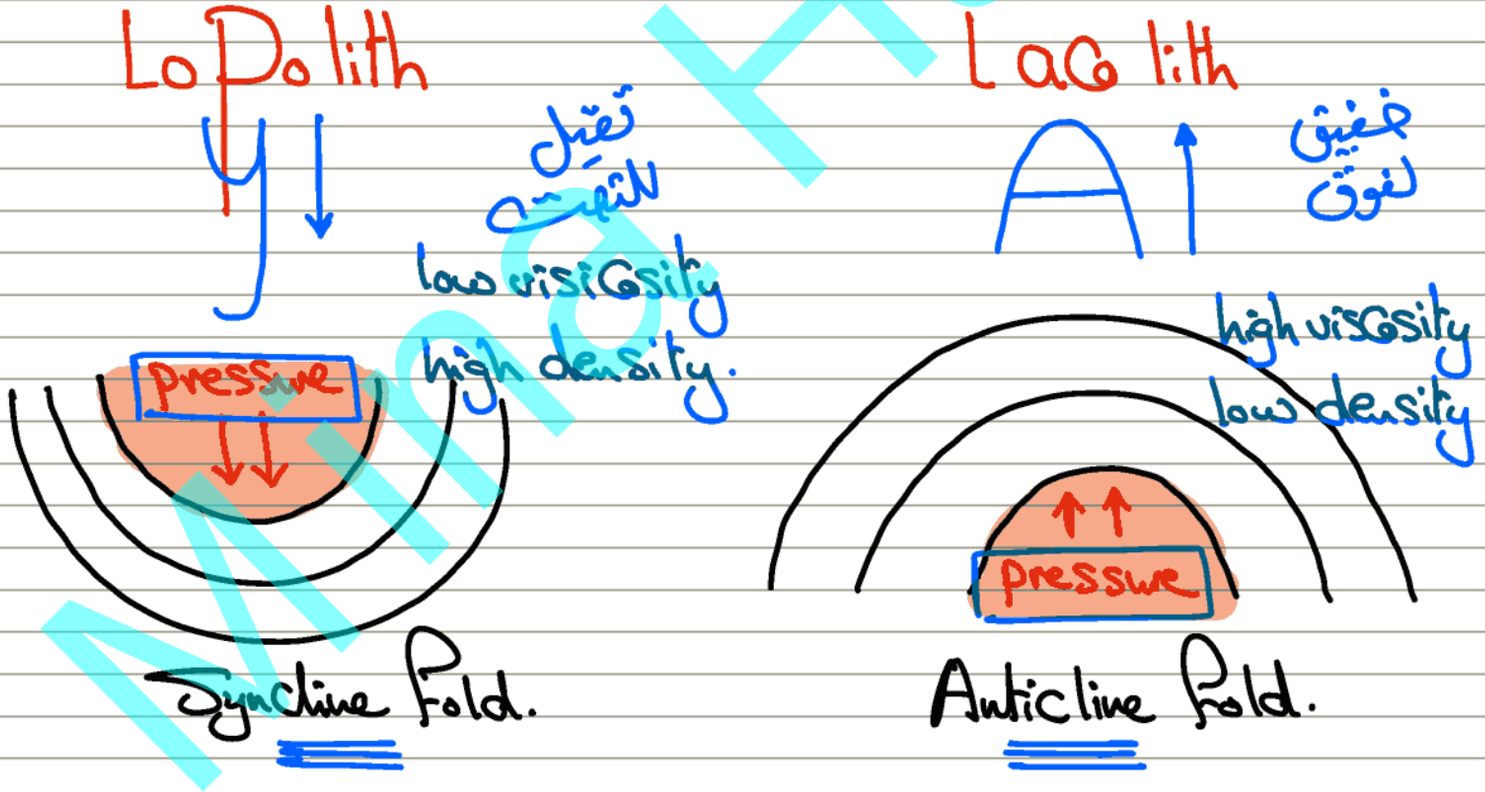
1 Batholith :- (عميق) → (وقت كبير وحجم كبير)

xx take very long time to crystallize magma intruded in earth's crust.

xx Takes Millions of years to cool down and 100's Kilometers.

Texture :- Coarse - large crystals.

2 Dome :- Magma accumulate through layers Horizontally where it arise from narrow slot Forming Dome.



3 Dyke :- Magma intruded cutting layers (intersecting layers). (قاطع الطبقات)

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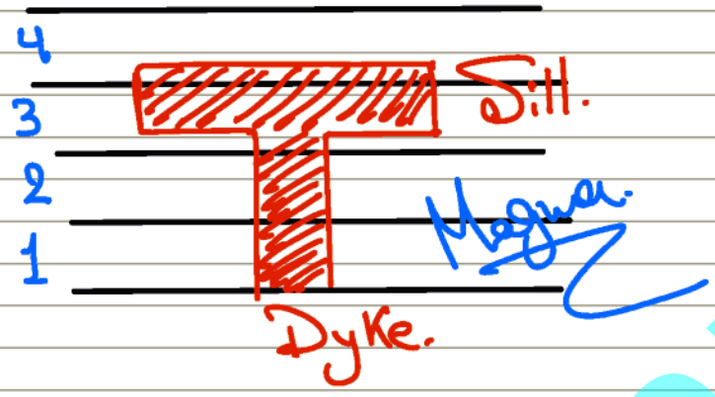
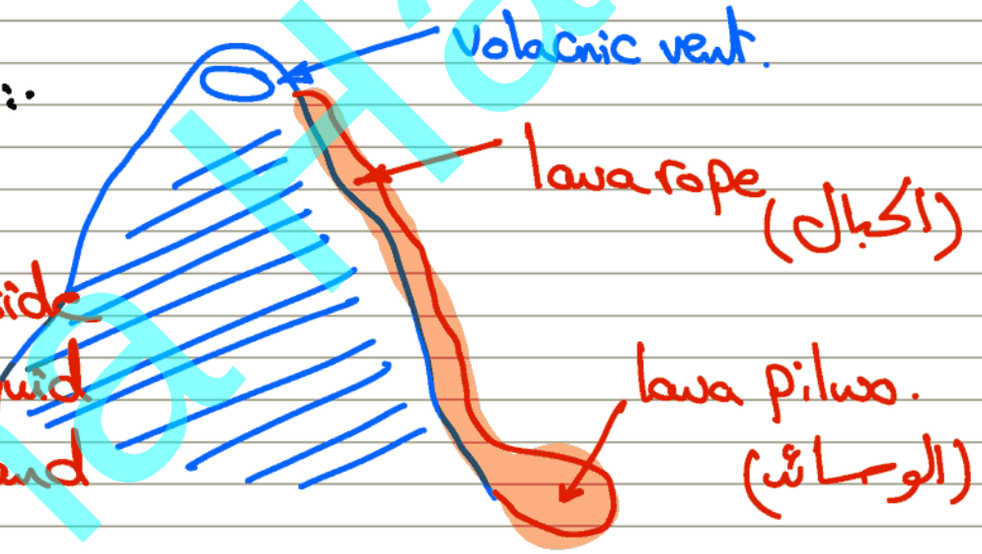
4 Sill :- Magma intruded horizontally along layers (Bedding plane)
متوازي مع الطبقات



B extruded volcanic.

1 lava Flow :-
Robes + Pillow
lava Flows outside volcanic vent liquid then Goldown and Solidifies.



Texture :- Glassy - Fourthy - Fine

2 Volcanic Pyroclastic :- (Solid فاكى بالك كدة)
exit of Ashes or Breccia which are Small sized resulted From breaking of volcanic Neck.

Ex): Volcanic Breccia :- Smooth Sharp edged rock.

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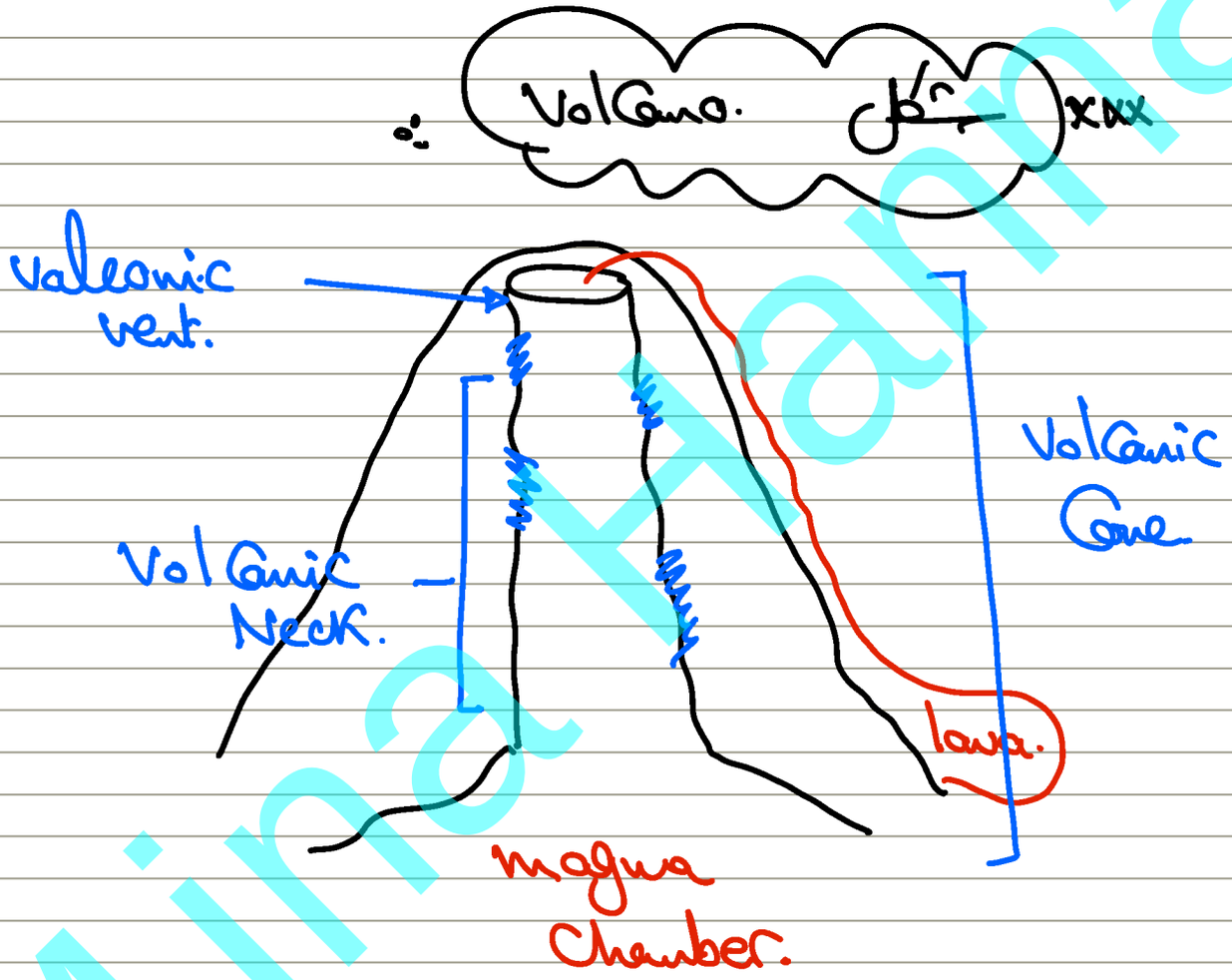
ex: Volcanic Ashes : Fine grains Carried by wind responsible For Fertility of Soil.

3 Volcanic bomb : (Solid صلبة كرية خاكى بالات)

Massive large Rocks oval Shaped rise up under pressure from volcano.



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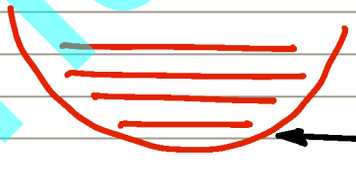
Second: Sedimentary rocks.

way of Formation :-

1. Fragmentation (weathering) ⇒ التعرية
   - physical (Mechanical).
   - Chemical.
2. Transportation (erosion) ⇒ النقل
   Need Natural Transporting agent → air - water
   عشان الحاجات اللى بتنقل تكون عايمة بالماء
   (Solid or Soluable in water)
3. deposition (sedimentation) ⇒ ترسيب
   deposition of sediments (grains) in a depositional basin. → oceans / seas.



lowest point on the Earth's surface.

4. Consolidation ⇒ التحجر
   under pressure and lithification with Cement material forming rocks.

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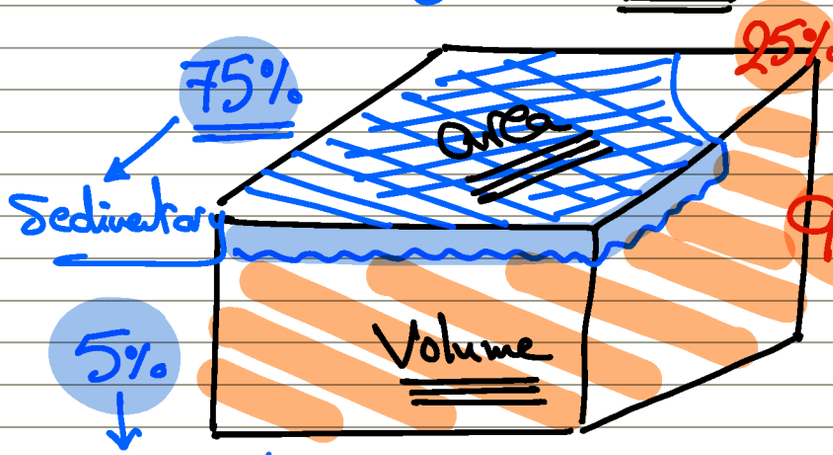
* General characters of sedimentary rocks :-

1. Covers 3/4 (75%) from Earth Crust in relatively thin layer. منه براحة كده كده .. و منجوة يعلم الله



25% → igneous - metamorphic.

95% → igneous - metamorphic.

2. Types → 90% :- Sandstone - limeStone - Mud Stone.

10% :- Coal - phosphrous - Salt - Hematite (iron).

3. have relatively high economic importance as (مهم جدا)

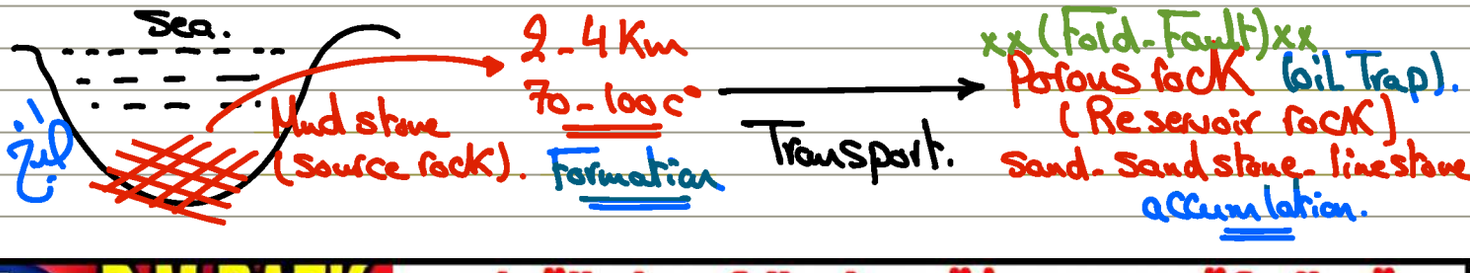
limestone : Cement

Sandstone : Cement - Glass

phosphrous : Fertilizer

Coal :- Source of energy.

4. related to Formation, Transportation and accumulation of oil & gases. → (مطبخ البترول)



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** Classification of Sedimentary rocks.

depend on mode of Formation.
(حسب الطريقة التكوين)

- Clastic Sedimentary Rocks. (Physical) (Mechanical) — عليه تفتيت
- Chemical Sedimentary Rocks. (Chemical Reaction) (Evaporation) — التفاعل كيماوي
- Biochemical Biogenic Sedimentary rock (Biochemical) — مربوط بالكائنات الحية

A Clastic sedimentary rock

Classified according to Size of fragments.
(حسب الحجم الجزيئات)

Gravel	2mm	Sand	64	Silt	4	Clay
الزلط	(2000 micron)	رمال	micron		micron	

mud — الطين

1 Gravel (الزلط)

more than 2mm (2000 micron).
Fragments in size of pebbles and Boulders.

Types → 2 types.

- Breccia — Sharped edged
- Conglomerate. — round gravels.

(Both must be Consolided by Cement material)

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2 Sand :- → Size :- 2000 micron → 64 micron.
(2 mm)

Types → 1 type Sand Stone.

(Quartez in Sand lithification and Consolidation Forming Sand Stone).

3 Mud :- → Size :-

Clay → less than 4 micron.

Silt → 4 micron to 64 micron.

Types → 2 types Mud stone. - Shale.

(Mud deposite & Consolided to Form Mud Stone → then pressure extered Forming Folliated (Sheets) = Shale.

B Chemical sedimentary rock.

depend on ① From evaporation of water and deposition of salts.

② increase Conc. of salt due to chemical reaction bet. Minerals in water.

1 Carbonate (CO_3) → limestone → Calcite.

dolorite → dolorite.

ex: Stalagmite - stalactite.
"ت للتحت M - فوق T"

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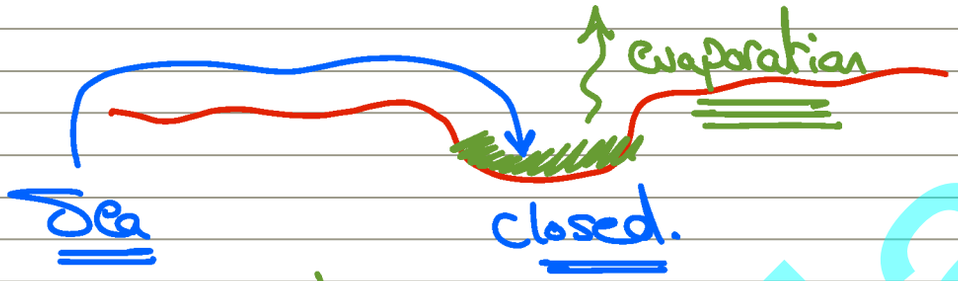
2 Silicate rocks (SiO_2) → Flint (chert).
Hunting في بيئة بحرية عميقة
Conchoidal Fracture ذات

3 Evaporate Rock → Salt deposited as a result of water evaporation from closed or semi-closed area.



examples :-
① Gypsum :- hydrous calcium sulphate.
② Anhydrite :- Calcium sulphate
③ Table salt :- Halite (NaCl).

أبيرنيا تستخرج الملح بتبخير الماء ونزل الحيات وتفصل الحيات عن الملح.

3 Biogenic - Bio Chemical Sedimentary
كائنات حية ماتت وأندفنت

1 Fossiliferous limestone :-
living organism (vertebrate or invertebrate) died and buried in Sea floor, their skeleton share and accumulate in seabed to form limestone.

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2. Phosphrous rock

organism as vertebrates Contain organic phosphate react in addition of Mineral phosphate to increase its Conc. of phosphate in Rocks.

Bio chemical. تفاعل بالكائنات الحية

** Energy resources in Sedimentary rocks **

oil / gas. | Kerogen | Coal.

1. oil / gas. :- They are not rocks and not Considered deposits as they are Formed and accumulated (stored) in Sedimentary rocks.

* way of Formation :-

1. living organism (aquatic plant + Animals) buried quickly in absence of atmospheric oxygen

Condition:

2. They are buried in Muddy rocks at depth (2 - 4 Km) at Temp (70 - 100 c°)

3. These organisms will change to liquid + gas hydro Carbon. (Formation).

4. Migration to Porous Rocks as Sand - Sandstone with lime Stone. (Resvior rocks).

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2 Kerogen (oil Shale) :-

Kerogen (Hydrocarbon) —480c° high Temp.→ oil / gas.

"in muddy Rocks"

xx Kerogen ⟵ plant orgin (من النبات)

xx waxy solid in mud rocks.

x usually Kerogen is important Source energy but Not Currently used ⟵

① price of production is very high.

② reserves until Natural gas is Consumed.

3 Coal :-

① plants are buried quickly in absence of Atmospheric oxygen

② in plant tissues, the volatile Compound will escape leaving only Carbon. which its Concentration increase gradually.

③ it happens usually in Swamp land due to rapid Burial espically Near to delta nile.

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* Metamorphic Rocks *

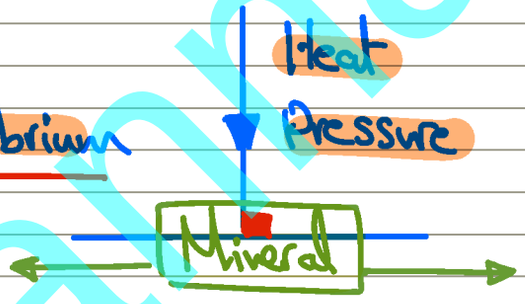
* Way of Formation :-

any Type of rocks (igneous - Sedimentary - metamorphic)
Change to anew rock (state) due to

① Heat or pressure. (Temp below melting point).

② Heat and pressure.

xxx Re Crystalization and re equilibrium to adapt New Condition.



large crystals ← Heat — نتيجة الحرارة
Called granules

Re Crystallized ← Heat/pressure — بتكون الحرارة مع الضغط
Folliated (Sheets)
(paralled to each other perpendicular to pressure.)

* Important Characteristics :-

1. Sometimes Mineral May Change to anew mineral in Metamorphic rocks
replacements يحدث بسبب Impurities وجود
Change in Crystal. يحدث بسبب elements

2. due to excessive heat, Change rock texture to granular which Contain More crystallized Form.

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[3] in presence of heat and pressure, it leads to arrangment of Mineral & recrystallization perpendicular to pressure applied.

* Types of Metamorphic *

[1] Massive Metamorphic rocks :-

** Change due to high Temperature leads formation of large Crystals.

** These rocks in Contact with magma or near to it Causing the Mineral to be More Crystallized and rock texture is granular.

effect of Metamorphism decrease ← (قل بالبعد) by moving away From magma.

ex : Marble → line Stone جاى (Sedimentary rock)

ex : Quartizite → Sand Stone جاى (sedimentary rock).

Impurities لو فيه Marbel ممكن يكون فيه (قل بالبعد) Forming veinied Marbel. (الرخام عروق)

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2 Foliated Metamorphic Rocks:

Crystal grow under effect of heat in a definite direction due to exerted pressure in Form of Sheets (Flakes)

exerted pressure على ⊥ Mineral توزيع في اتجاه

ex:- Slate rock:

Mud → Mudrock → Shale

(Sedimentary)

low pressure

200°C Low Temp. high pressure.

Slate: Enter Construction

ex:- Mica Shist:

Mud → Mudrock → Shale + Mica

(Sedimentary)

low pressure

high Temp. high pressure.

Not intermited حتى متقطع

Mica Shist: Parallel Sheets of Mica & Thin and inter Connected (متصلين)

ex:- gneiss → Granite (igneous rocks) من

Parallel Sheets and Not Connected غير متصلة

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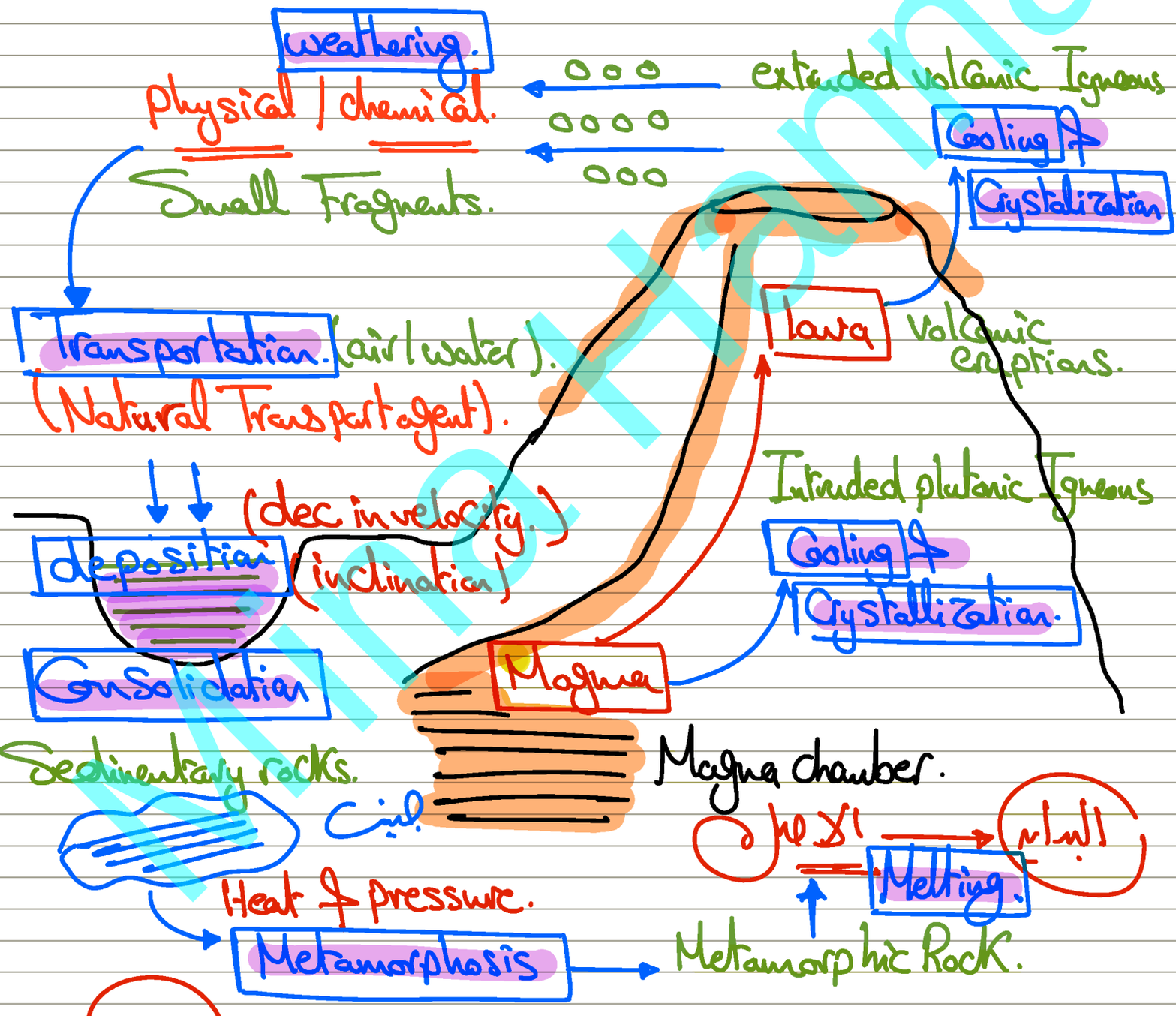
Rock cycle

Scientist named James hutton make rock cycle that contain all 3 Types of rocks that appeared due to atmosphere & hydrosphere.



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Dr. Nivan كل سنة وأنت طيب

D.M.RAZK موقع الدكتور محمد رزق معلم الكيمياء التعليمي

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